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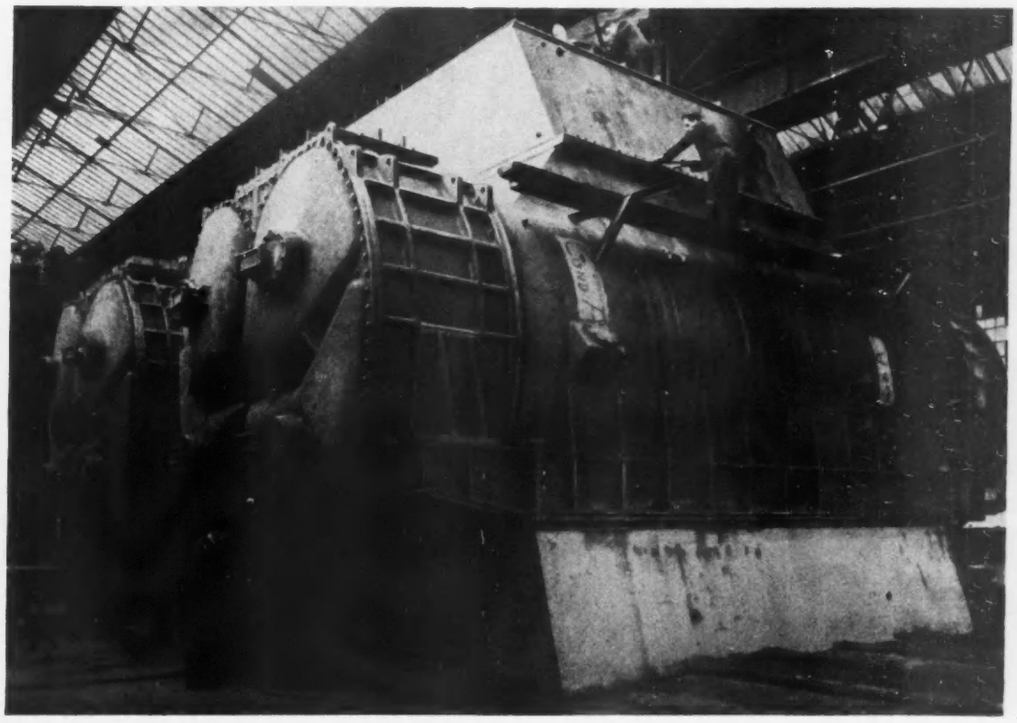

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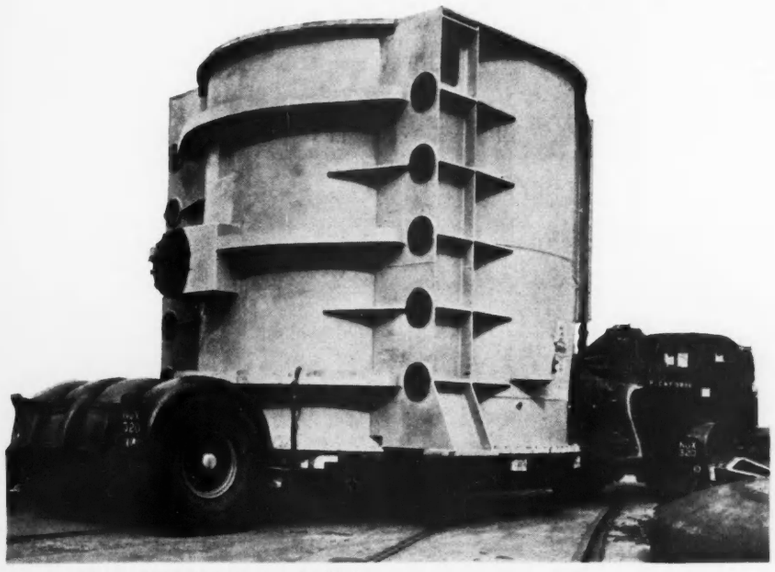

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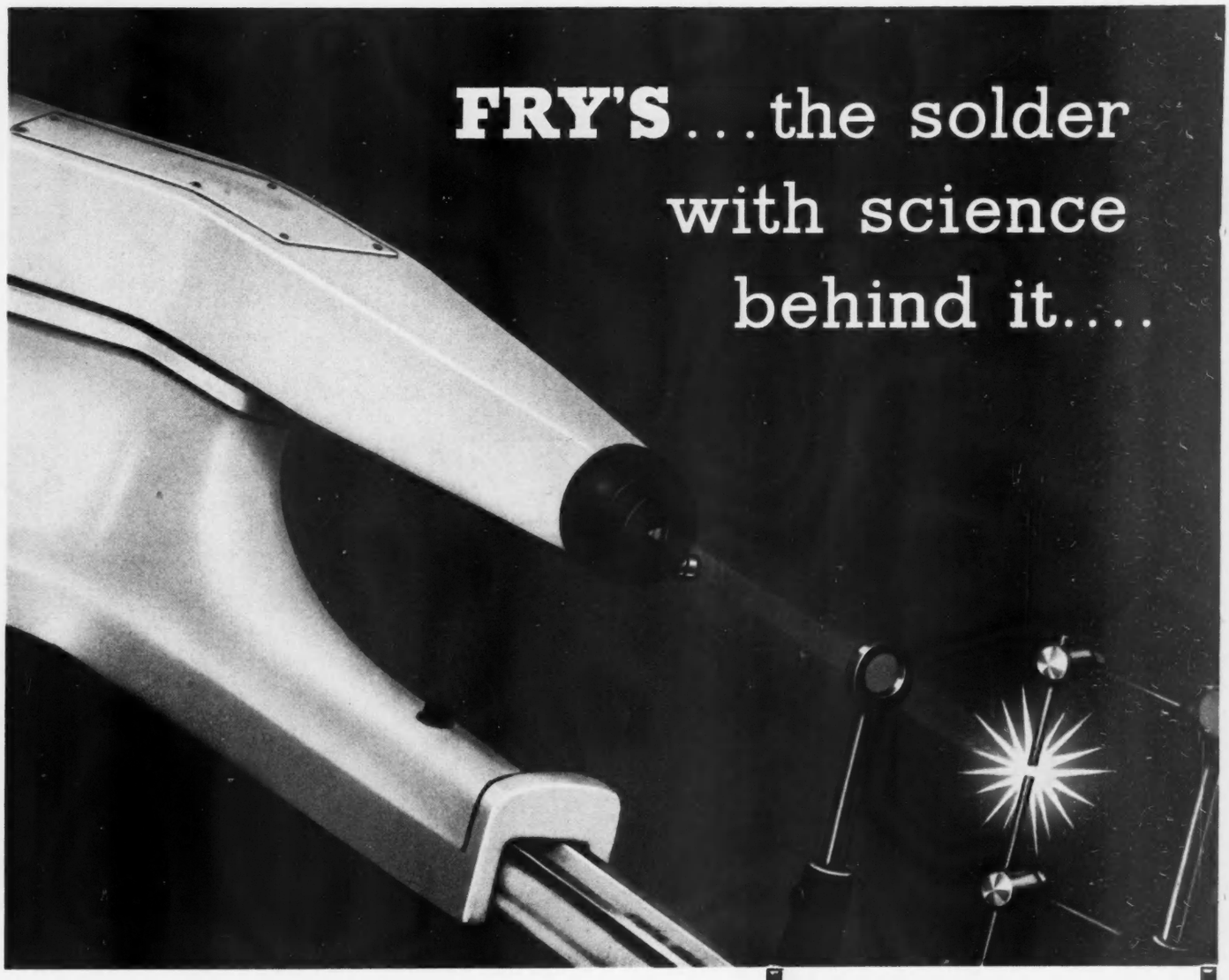

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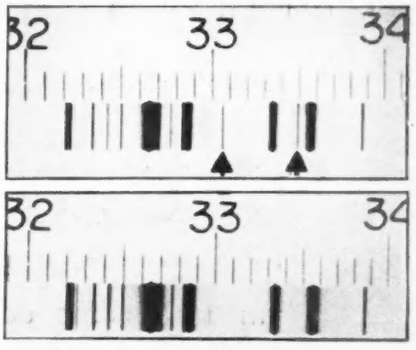

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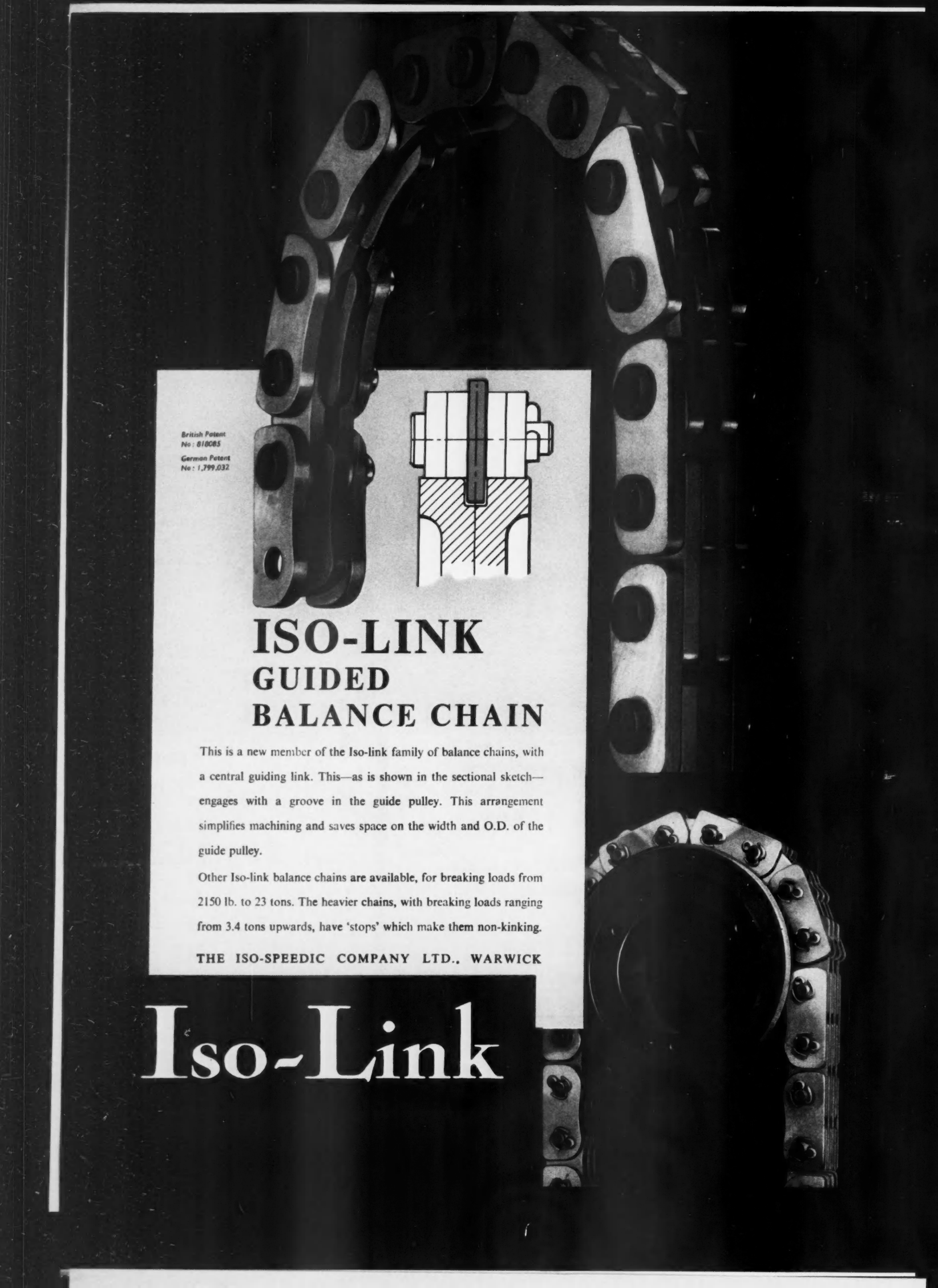

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11 March 1960

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Wing section of a Victor bomber in a test rig that includes two turbojets which are being made ready to run. (*Nurnberg photograph for* ENGINEERING.)

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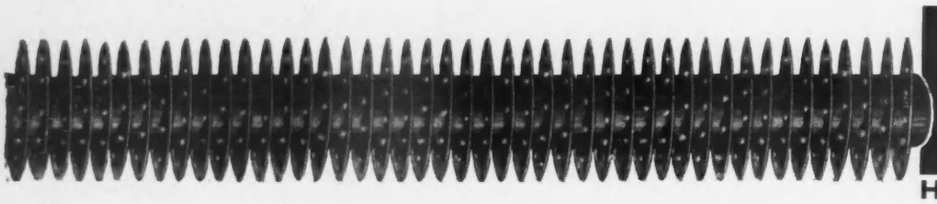

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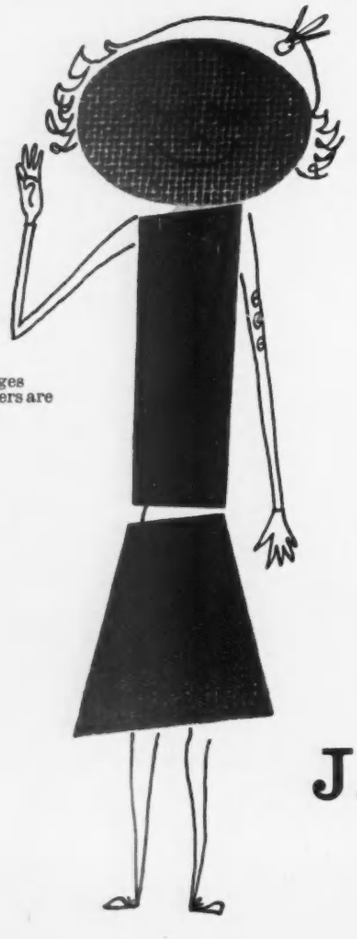

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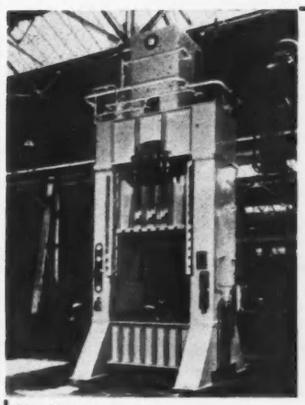

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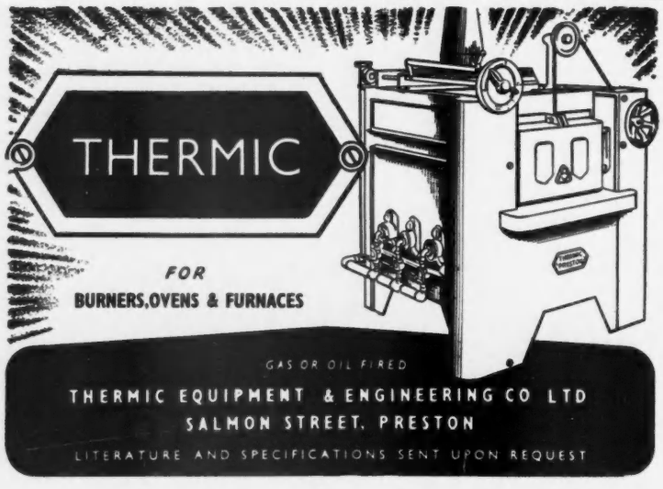

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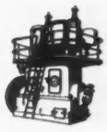

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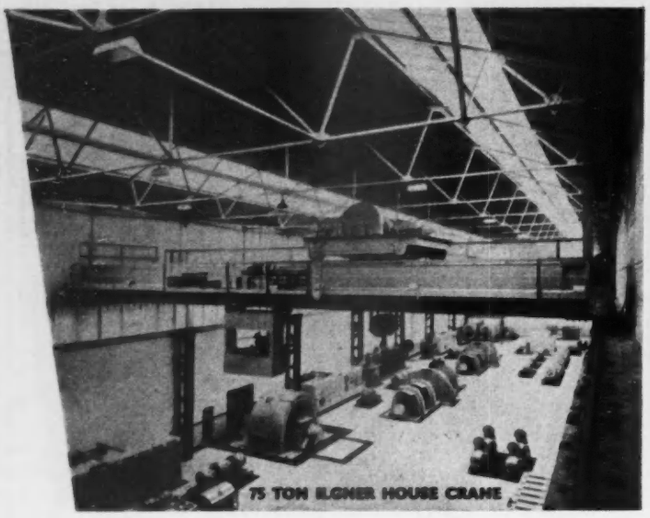

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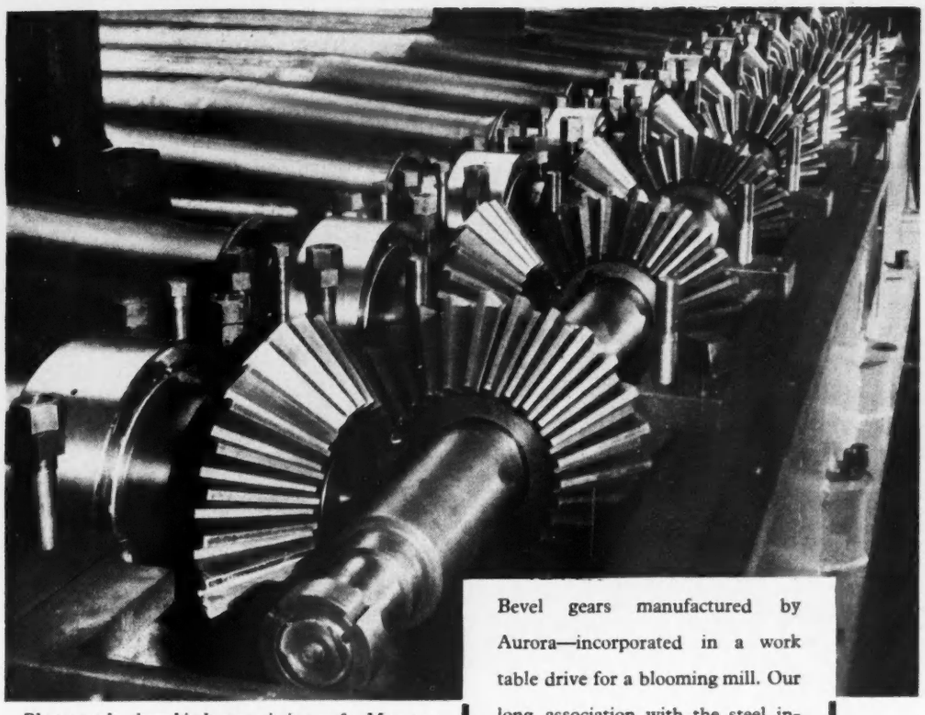

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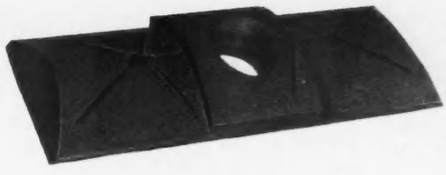

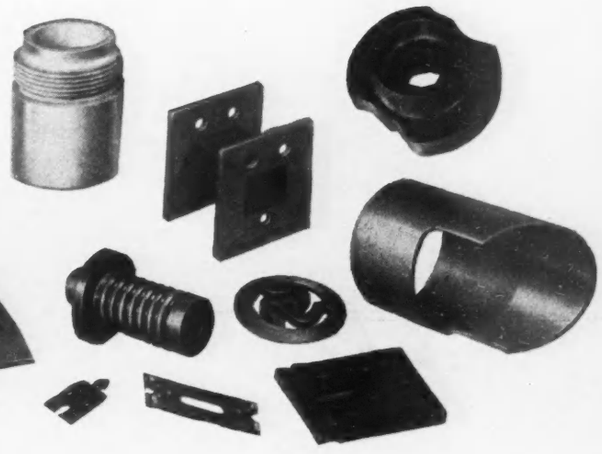

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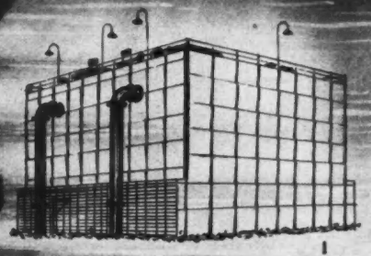

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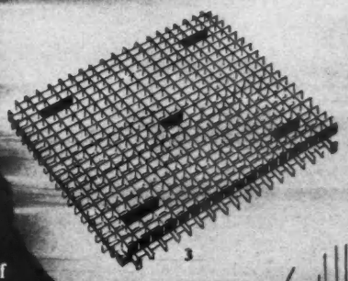

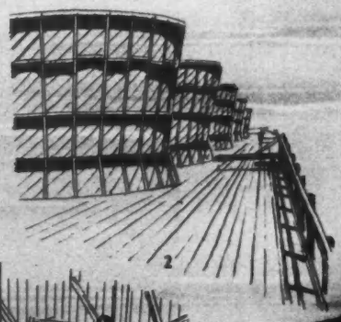

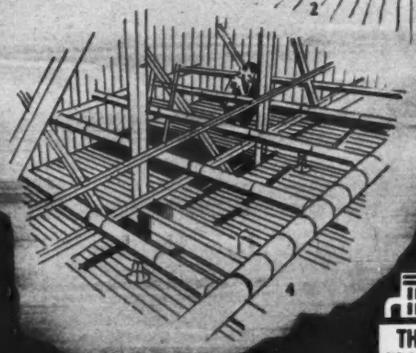

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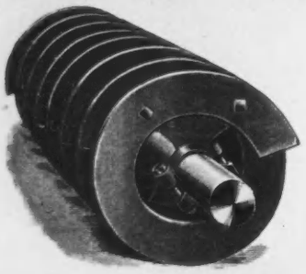

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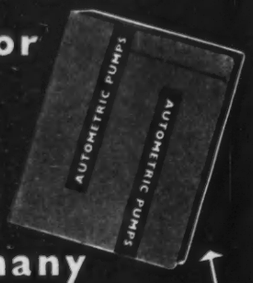

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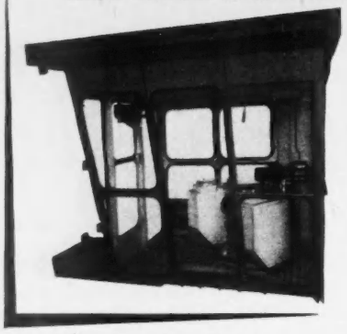

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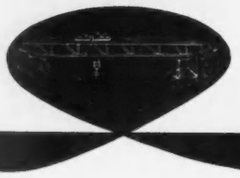

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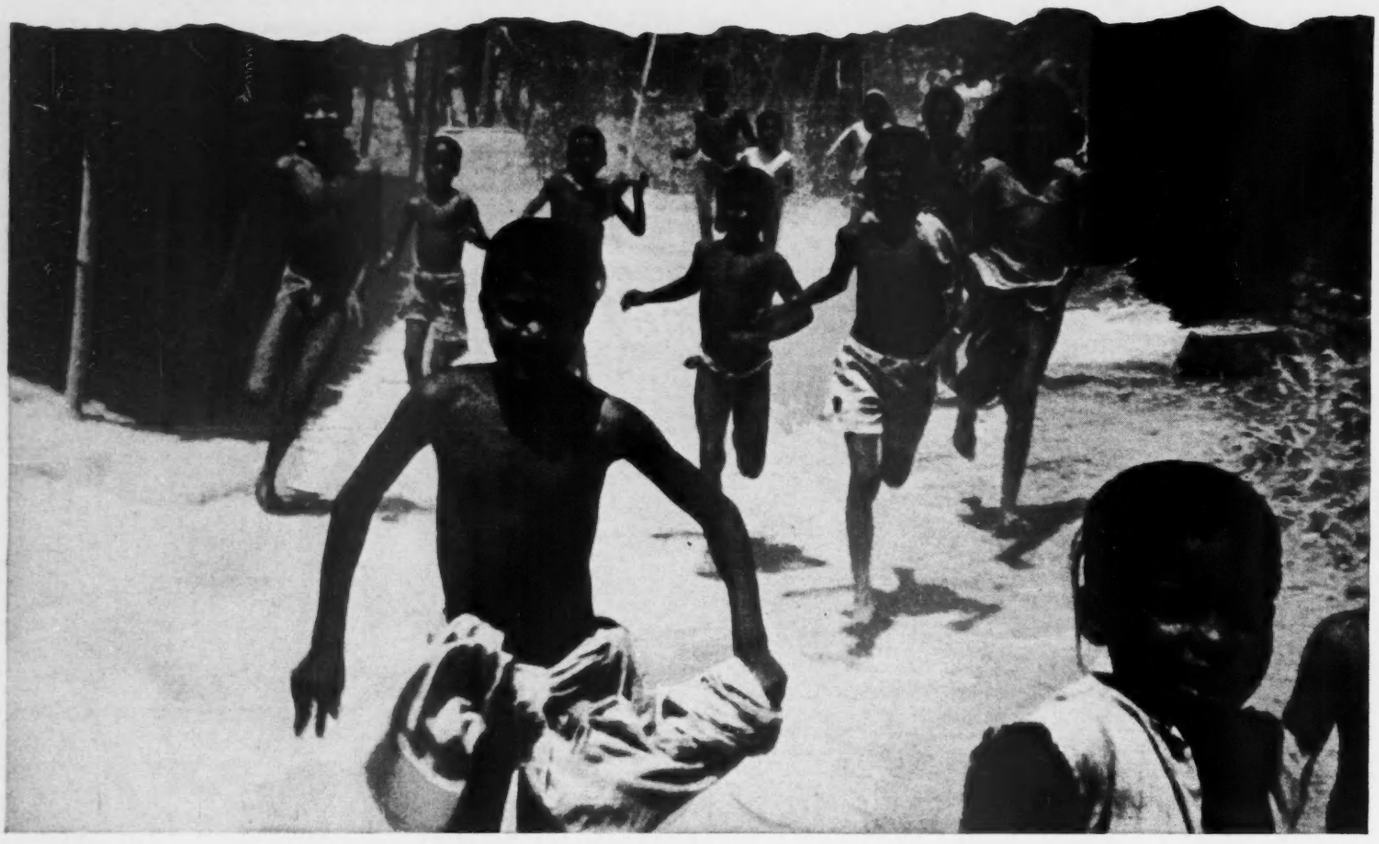

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"Ranmore"
a high-bay
lighting fitting
especially designed
for use with the new
colour corrected
mercury vapour
lamps

New
FALKS Fitting
offers
startling
cost-cutting
value

"Ranmore" has only two basic parts, a light alloy carrier and a spun-aluminium reflector. The latter is made in three inherently-efficient sizes, each with a 20 deg. cut-off—a vital feature in a high-mounting fitting—and each using the same carrier. "Ranmore" is easy to install and maintain. In fact, only "Ranmore" offers such remarkable simplicity and efficiency . . . such startling, cost-cutting value.

EASY OVERLAMP DETACHMENT OF REFLECTOR

FALKS, the long-established lighting specialists, designers and manufacturers of all types of fittings.
Lighting Engineering Services freely available.
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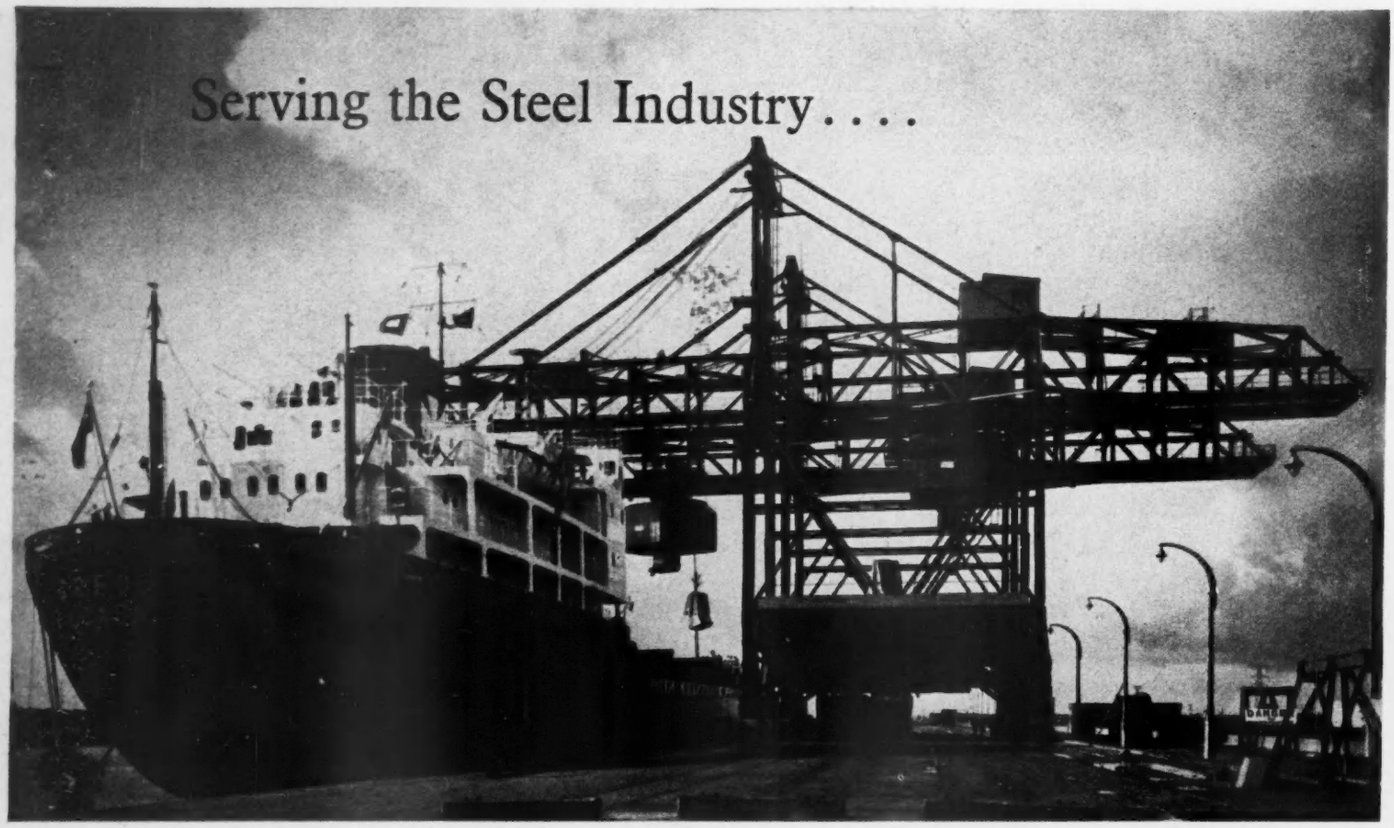

From ore unloading, hot metal pouring and section handling to shipping the finished product, the Clyde-Booth range covers the field of heavy materials handling for the Steel Industry.

Manufacturers of

Ore Transporters
Steelworks Cranes
Diesel Rail Cranes
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MOSSEND, Lanarkshire.
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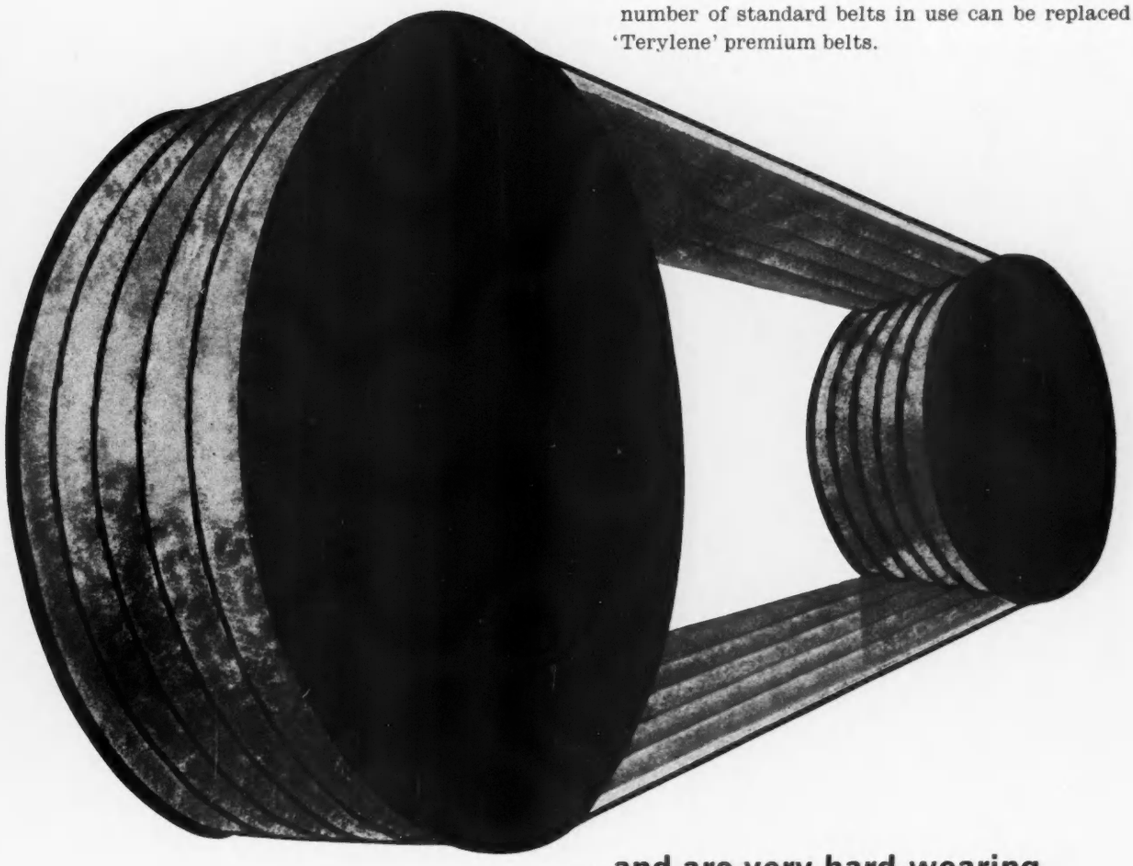
'TERYLENE'-reinforced V-belts last up to three times as long as standard belts

Users all over the country are finding that 'Terylene' premium V-belts are one of the most exciting and significant developments in power transmission for years. They save money, maintenance, and production time, and often the number of standard belts in use can be replaced by *fewer* 'Terylene' premium belts.



. . . and are very hard-wearing

In addition to their unusually long life, 'Terylene' premium V-belts offer the following advantages:

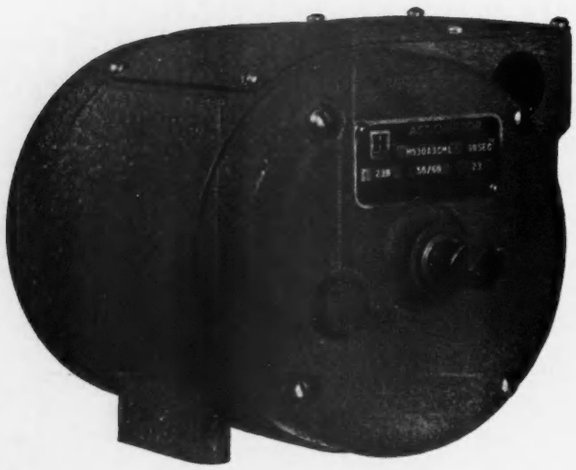
Resistance to oil
heat
static electricity
flex
rot
stretch and slip in use
shock loading
moisture *(which means greater dimensional stability in storage)*

'TERYLENE' Polyester ICI Fibre

Send for our leaflet about 'Terylene' premium V-belts, and for any special information, to I.C.I., Fibres Division, Harrogate, Yorkshire.

'Terylene' is the trademark for the polyester fibre made by
IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON TE 519

New



Type A Actionator motors are ideal for rotary plug valves, dampers, butterfly valves, etc. Features include internal brake and micro switch limit switches.

ACTIONATOR

heavy duty electric motors for valves and dampers

Use the powerful new Actionator industrial type motors to operate slip stem valves, rotary plug valves, butterfly valves, dampers, etc.

Variety of speeds

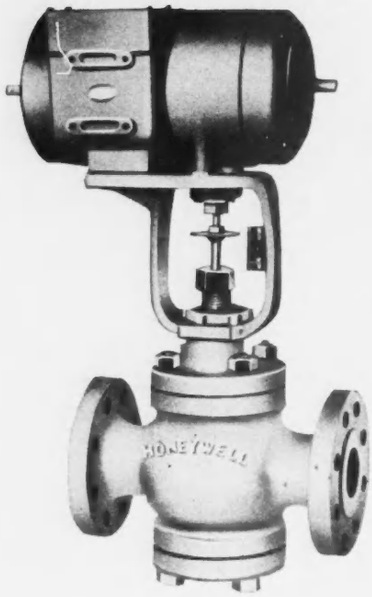
Actionator motors are available with a variety of speeds, from 9 to 144 seconds full-stroke operation. The high speed permits use with pulse-type controllers such as those used in radiant tube firing. Torque ratings range to 200 lb.-inches.

All control forms

Models are available with two-position, floating, and proportional control. Optional models can include cam-operated, internally mounted switches for a variety of dual switching purposes.

Write now

for more details, or send the coupon to Honeywell Controls Limited, Ruislip Road East, Greenford, Middlesex. WAXlow 2333. Branch offices in principal towns and cities of the United Kingdom —and throughout the world.



Type B Actionator motors are designed for vertical acting slip stem valves having lifts of from ¼ inch to 1¼ inches. Double ended shaft can also simultaneously operate butterfly valves, rotary stem valves and other devices through suitable linkages. Features include built-in linkage and strain relief, mounting yoke and enclosed terminals with gasketed housing. No auxiliary mounting bracket required.

Honeywell

H HONEYWELL First in Control SINCE 1885

Please send me a copy of:

Specification Sheet S804-3 (Type A) ☐
Specification Sheet S1016-2 (Type B) ☐

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Natural, synthetic and silicone rubbers

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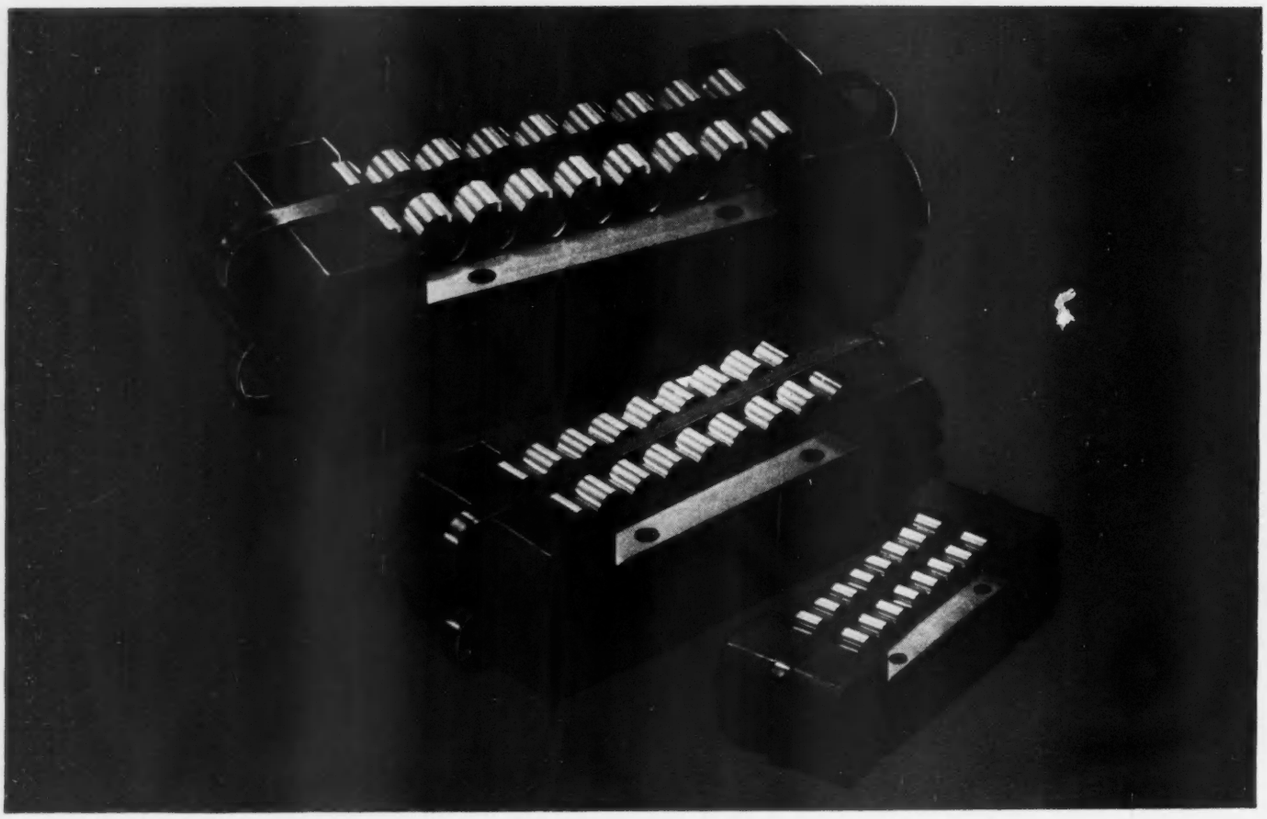
NOW available from Rotax!

Tychoway Recirculating Anti-friction way Bearings



Rotax now offers you a wide range of Tychoway bearings for use in machines requiring a very high degree of linear accuracy, very low friction and long accuracy life. A return channel within the race provides easy, accurate assembly directly to a precision machined flat surface which can be supplied to customer's specification if required. This eliminates hand fitting of the slides. Centre guided rollers end the problem of skewing usually met in roller ways. All working parts are made of through hardened EN31 bearing steel to provide long bearing life and operational accuracy.

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- FRICTION FREE
- ELIMINATION OF WEAR
- UNLIMITED TRAVEL
- NO "SLIP-STICK"
- MINIMUM LUBRICATION
- SURFACE WIPERS
- FEED POWER REDUCTION

If you would like information on Tychoway Bearings, Recirculating Ball Threads, Switchgear, Compressors, Railway Point Machines, Level-crossing Barriers, Road/Rail Van Actuators, Pneumatic Motors, please write or telephone :

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LUCAS-ROTAX (AUST.) PTY. LTD., Melbourne and Sydney, Australia.
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FROM Zero to 12 tons at the touch of the foot. Think of the work you could do with a Press that delivers 12 tons Pressure on a 12″ x 12″ worktable. There's ample room too for the project you have in mind if it can be incompassed within the 12″ Daylight and 12″ Throat available. Speedy too, with it's 6″ stroke, 4 seconds down and 3 seconds return with both hands free to handle the work. Compact in size and weighs only 10¼ cwts.

A really economical "buy" at the Ex works price of £215.

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PILOT WORKS LTD

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Do you wait for hot water on a cold Monday morning?

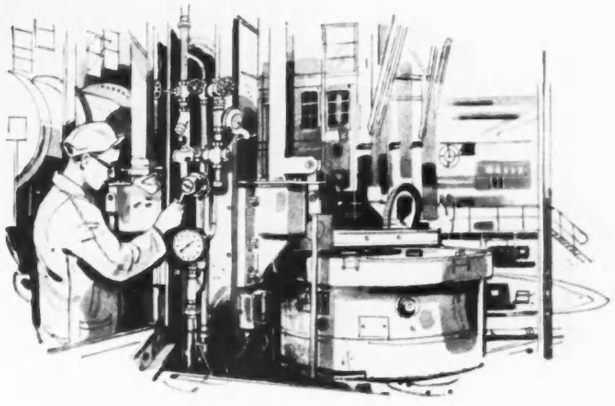
Where hot water is provided from a storage system there is a waiting period when production starts, for the water to heat up in the storage tanks.
With Leonard Steam Water Mixers there is no waiting period. Hot water is available as soon as the steam is turned on.

Do you use cold water when you would like to use hot?

When vegetables are cleaned for canning they are washed in a running stream of water. If the water is too cold the girls' fingers get numb and their production slows down. If it is too hot the vegetables are spoilt. A Leonard Valve looks after the temperature, the girls' fingers and the vegetables.

How would you raise the temperature of a spray very gradually from cold to 120 degrees?

Leonard Valves fitted to the sparge pipe on a cloth scouring and milling machine enable the scourer to vary the temperature to suit the work and to make changes in the temperature during the process gradually, giving a cleaner scour and a better finish.



These are specific examples. Your use of Leonard Thermostatic Steam Water Heaters will probably be different. Write for help. (Our folder H/6)

WALKER CROSWELLER & CO. LTD.
Cheltenham
Telephone Cheltenham 56317

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Acheson Colloids Limited

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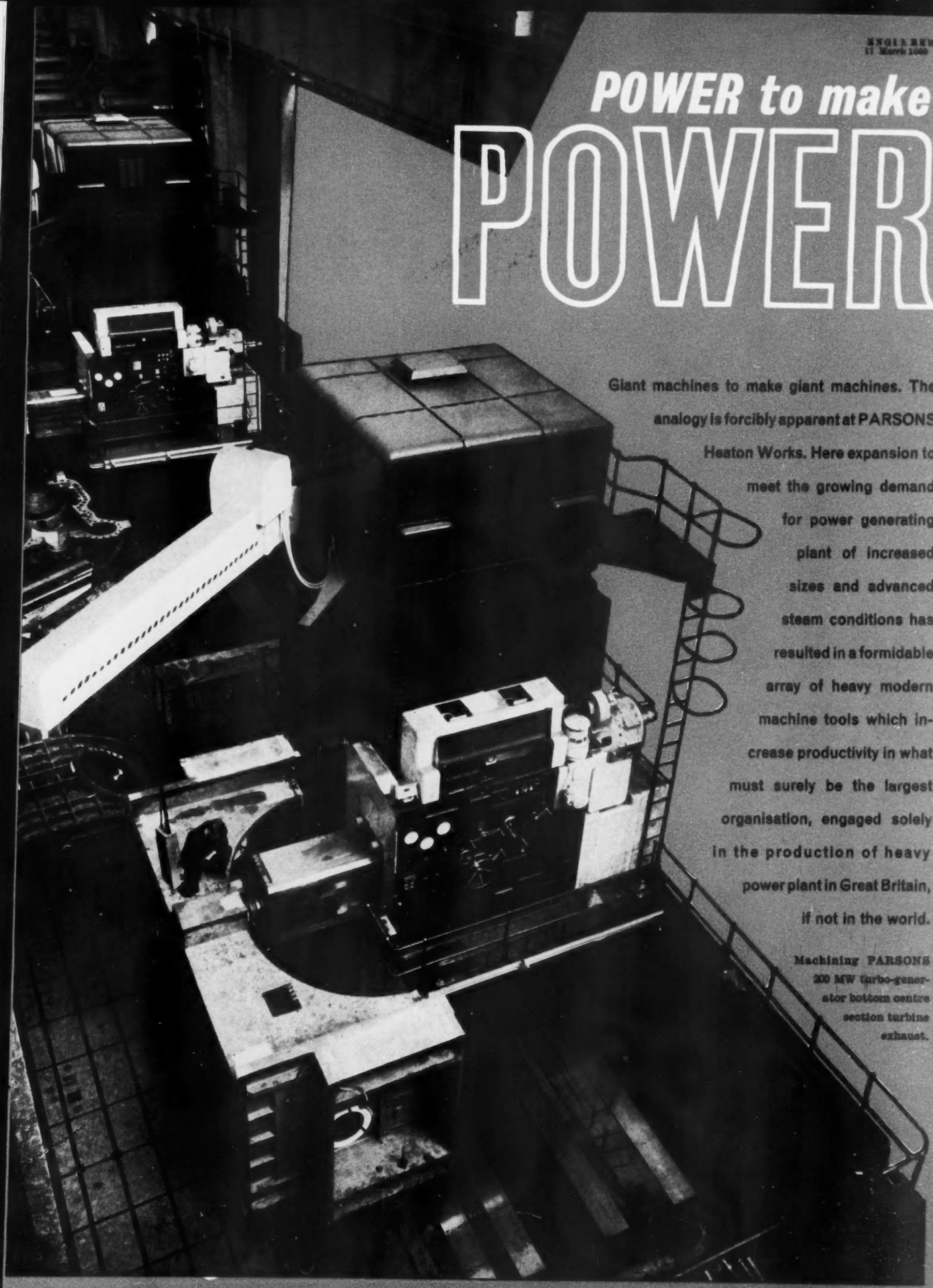
POWER to make POWER

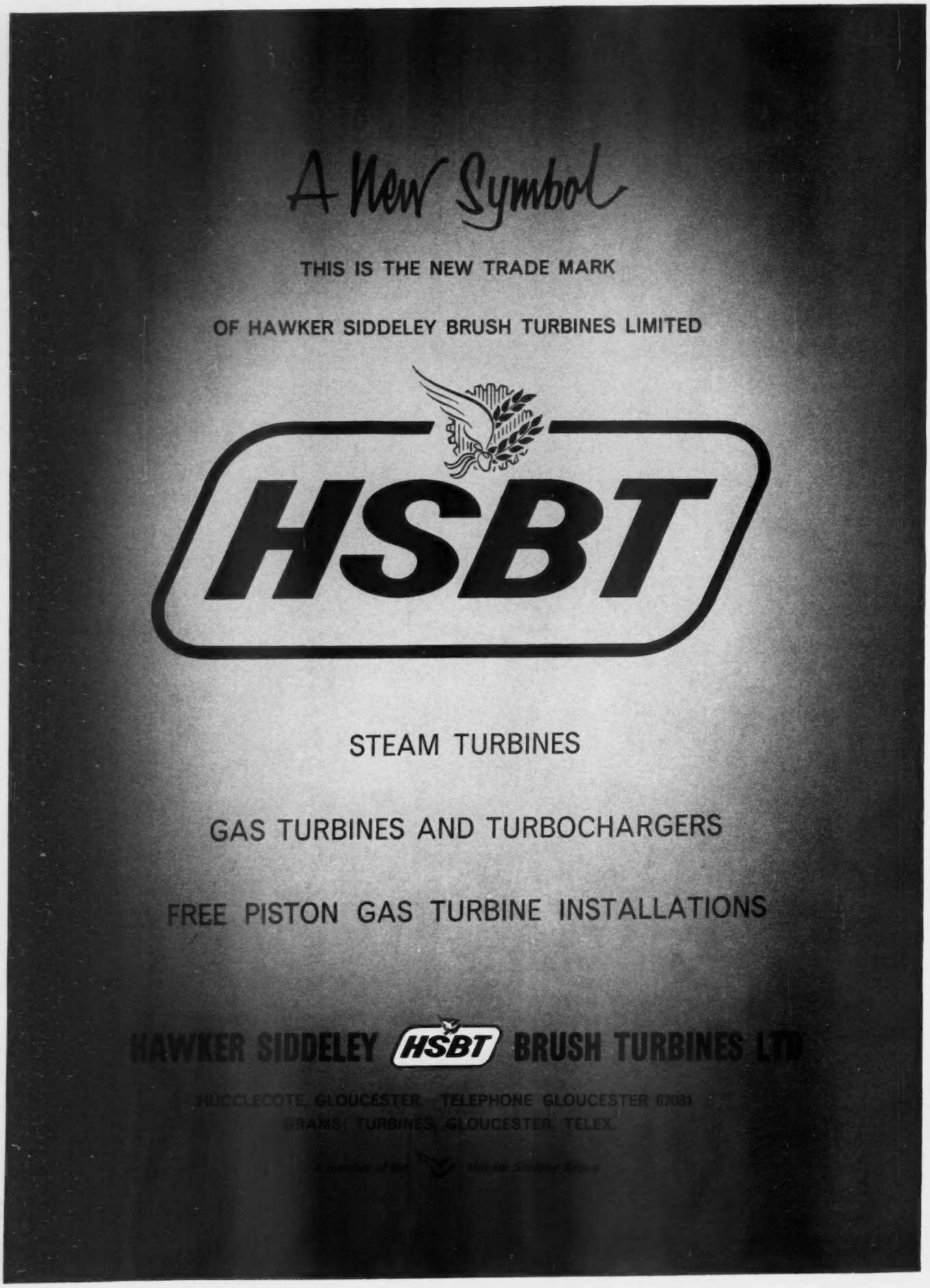


Giant machines to make giant machines. The analogy is forcibly apparent at PARSONS Heaton Works. Here expansion to meet the growing demand for power generating plant of increased sizes and advanced steam conditions has resulted in a formidable array of heavy modern machine tools which increase productivity in what must surely be the largest organisation, engaged solely in the production of heavy power plant in Great Britain, if not in the world.

Machining PARSONS 200 MW turbo-generator bottom centre section turbine exhaust.

PARSONS TURBO-GENERATORS AND TRANSFORMERS

C. A. PARSONS & CO. LTD · HEATON WORKS · NEWCASTLE-UPON-TYNE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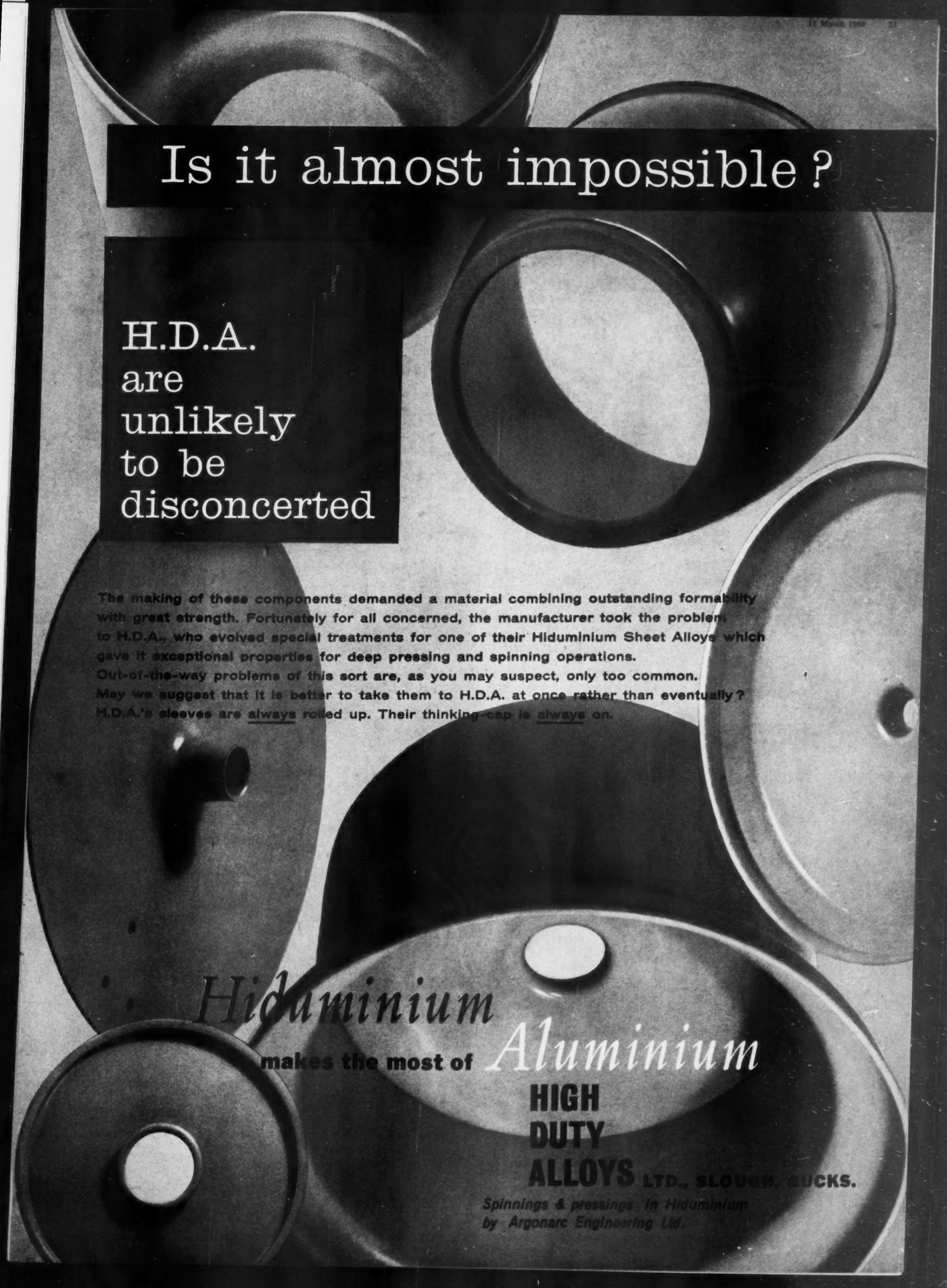

Is it almost impossible?

H.D.A. are unlikely to be disconcerted

The making of these components demanded a material combining outstanding formability with great strength. Fortunately for all concerned, the manufacturer took the problem to H.D.A., who evolved special treatments for one of their Hiduminium Sheet Alloys which gave it exceptional properties for deep pressing and spinning operations.
Out-of-the-way problems of this sort are, as you may suspect, only too common.
May we suggest that it is better to take them to H.D.A. at once rather than eventually?
H.D.A.'s sleeves are always rolled up. Their thinking-cap is always on.

Hiduminium makes the most of *Aluminium*

HIGH DUTY ALLOYS LTD., SLOUGH, BUCKS.

Spinnings & pressings in Hiduminium by Argonarc Engineering Ltd.

ENGINEERIN
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Hycar in the 'sandwich'

makes a perfect seal

Resilience, low set, resistance to oils and solvents—all the outstanding properties of Hycar are embodied in a new sealing material called Hy-Clad. Available as single or multi-layer laminates, the 'sandwich' is made by bonding a layer of Hycar to light alloy sheet. The metal gives rigidity to washers, gaskets, pump seals, hydraulic packings, oil seals of every kind. Hycar's flexibility and durability ensures fluid-tight seals that can be used over and over again. The properties of Hycar, the world's leading synthetic rubber, are discussed in Booklet No H/138. Please write for a copy.

Hy-Clad is made by Fireproof Tanks Ltd. using Hycar synthetic rubber

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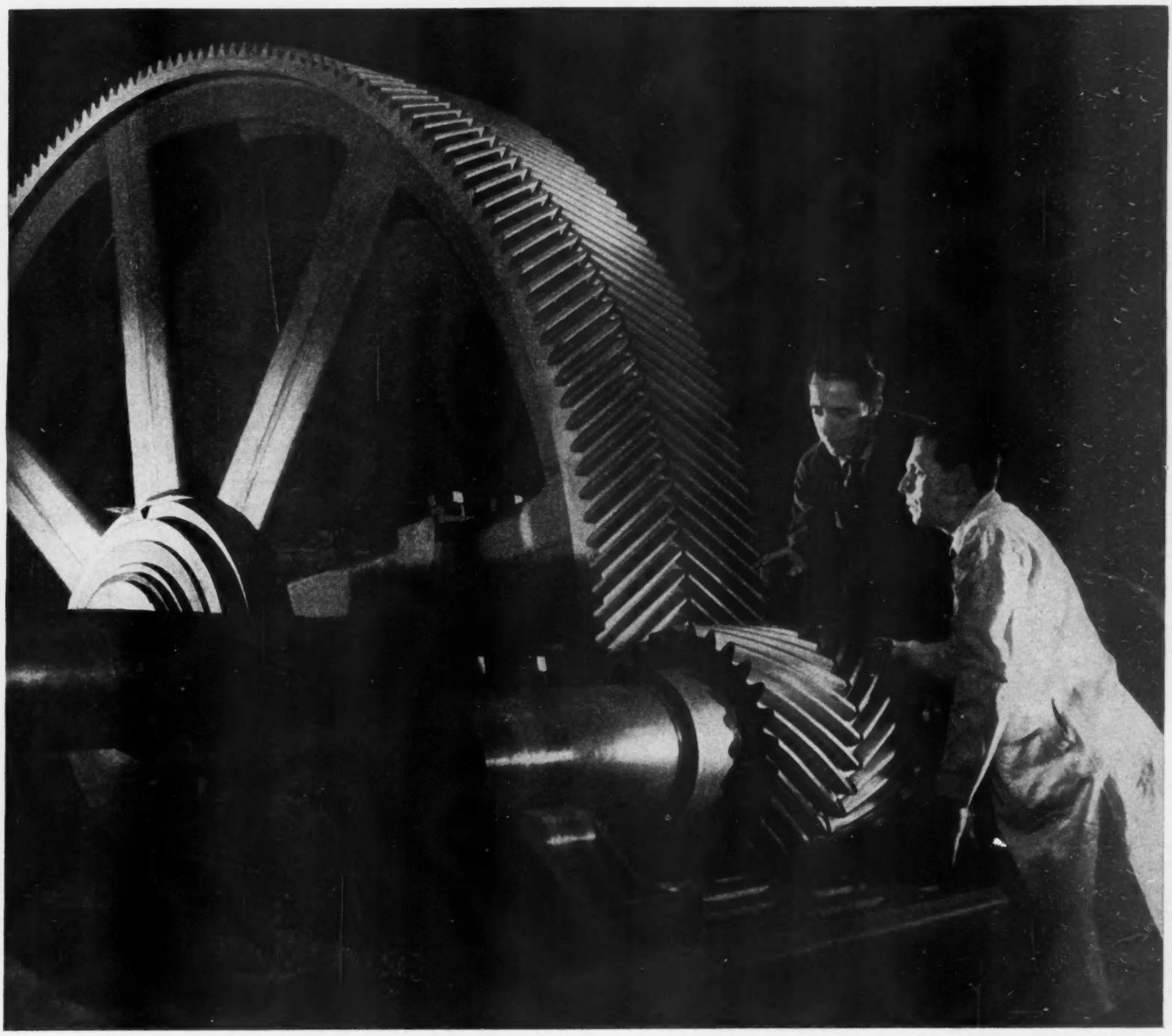

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The top gear today, of course is made by David Brown — just as it has been for one hundred years. And there's a good reason for this universal approval of a famous name — for David Brown make the biggest range of gears in the country. Everyone is fully proved and unsurpassed in its class for accuracy, quiet running and dogged dependability.

It adds up to this — more and more manufacturers are going straight into top with David Brown gears.

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GENERAL GEAR DIVISION, PARK WORKS, HUDDERSFIELD. TELEPHONE: HUDDERSFIELD 3500

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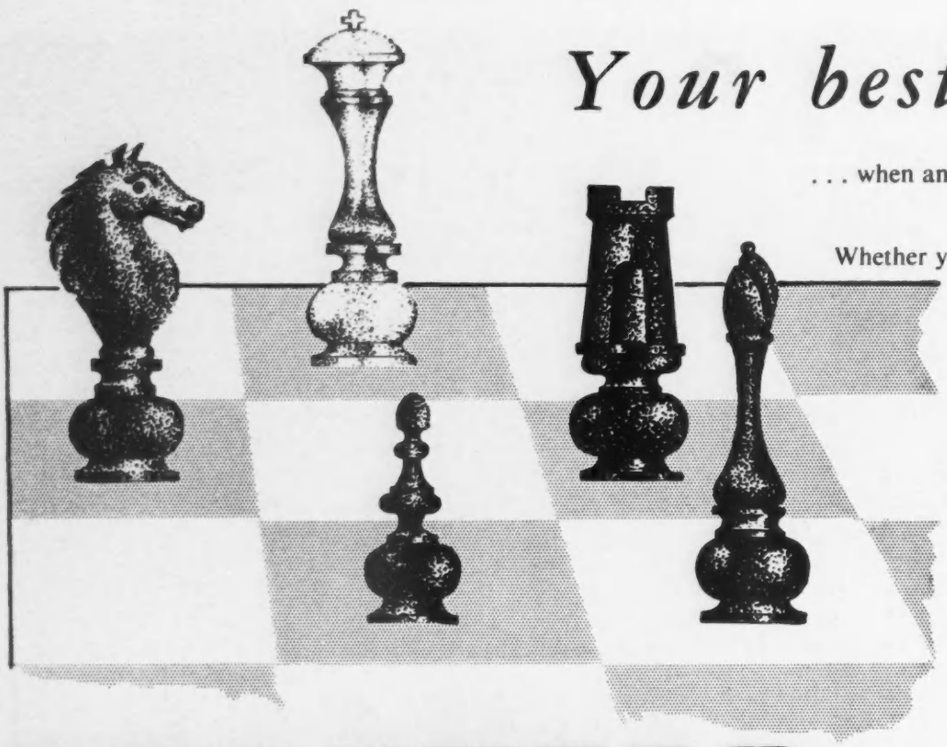

Your best move...

. . . when any problem appears on the board is to check with Brayhead. Whether your business is pressing (sorry!), components or springs, Brayhead can help you. The earlier any problem is started on, the better the chance of avoiding a stalemate—be it production, design or research; so move to B (Brayhead) and let them solve it for you!

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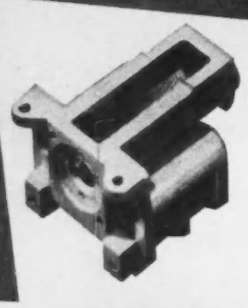
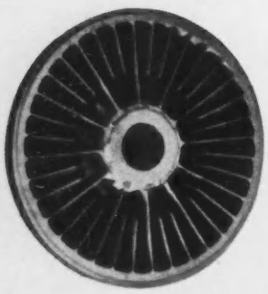


PRESSURE DIE CASTING

Our large capacity battery of Pressure die casting machines delivers large quantities for continuous supply including these Frames in Zinc-based Alloy BS.1004A.

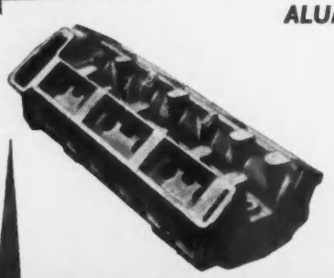
GREY IRON CASTINGS

Our highly mechanised Iron foundries can supply castings up to 500 lbs. weight from the five mechanised units or up to 5 tons from the floor casting foundry.



GRAVITY DIE CASTINGS

Examples of Aluminium Alloy Castings supplied on regular delivery ON TIME — Fluid Flywheel Rear Casing in L.M.23.



ALUMINIUM SAND CASTINGS

The Aluminium Foundries also include mechanised and jobbing sections and many intricate castings, such as these Cylinder Heads in L.M.4 Aluminium Alloy, are produced in quantity.

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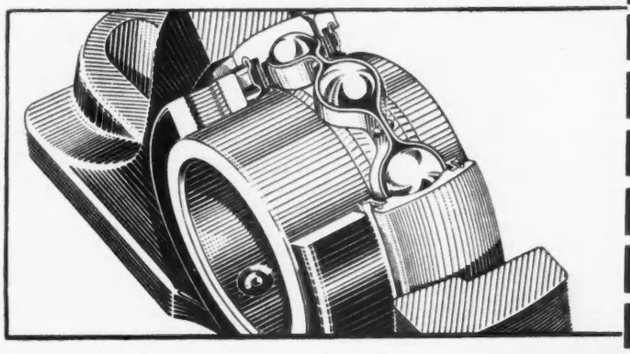
FENNER DODGE plummer blocks

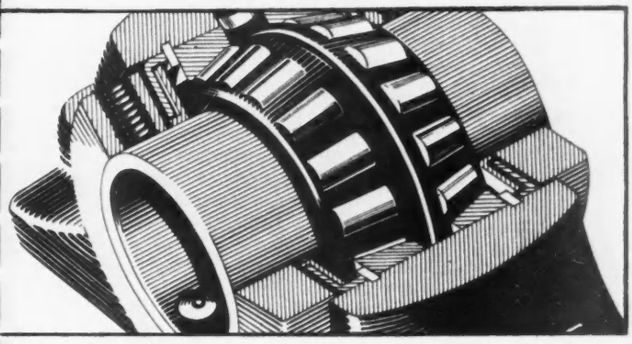
TYPE S C

WITH SEALED BALL BEARINGS

Used for moderate loadings on shafts ¾″ to 2½″ diameter. There are 30 bore sizes available in 1/16th inch steps.

RUGGED · STREAMLINED
SELF ALIGNING · SEALED





TYPE E

WITH TIMKEN ROLLER BEARINGS

Designed for the more heavily loaded shafts in the range 1¼″ to 5″ diameter. Choice of 15 bore sizes in ¼″ increments is available.

RUGGED · HIGH SPEED SUITABILITY
POSITIVE LOCK ON SHAFT · LOW PRICE

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The DIAPHRAGM

- isolates fluids from mechanism
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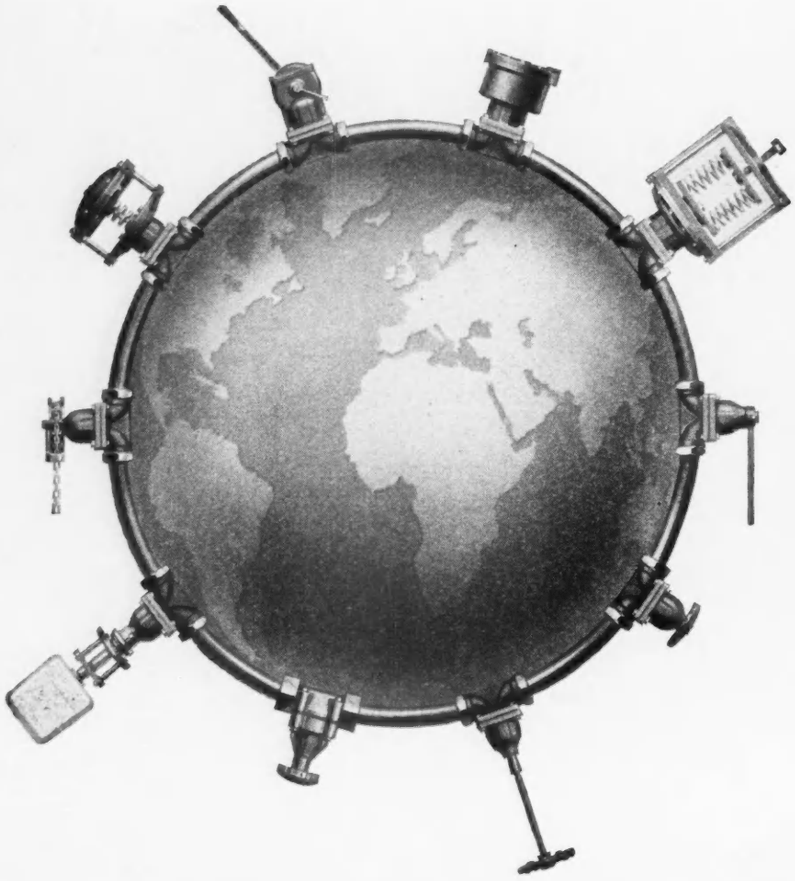

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DIAPHRAGM VALVE DIVISION
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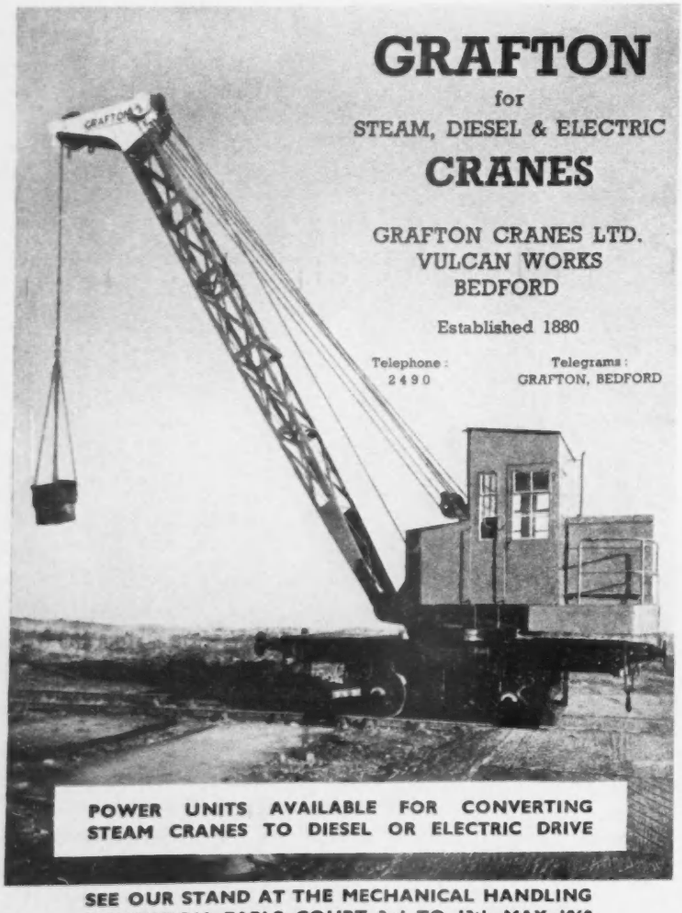

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CRANES

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VULCAN WORKS
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POWER UNITS AVAILABLE FOR CONVERTING STEAM CRANES TO DIESEL OR ELECTRIC DRIVE

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12 in. DEEP

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- *Shelves adjustable every inch.*
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- *6 shelves per bay — Extra shelves 8/- each.*
- *Quantity discounts.*

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Ready for erection in England, Scotland and Wales

ALSO AVAILABLE IN WHITE AT £5 PER BAY

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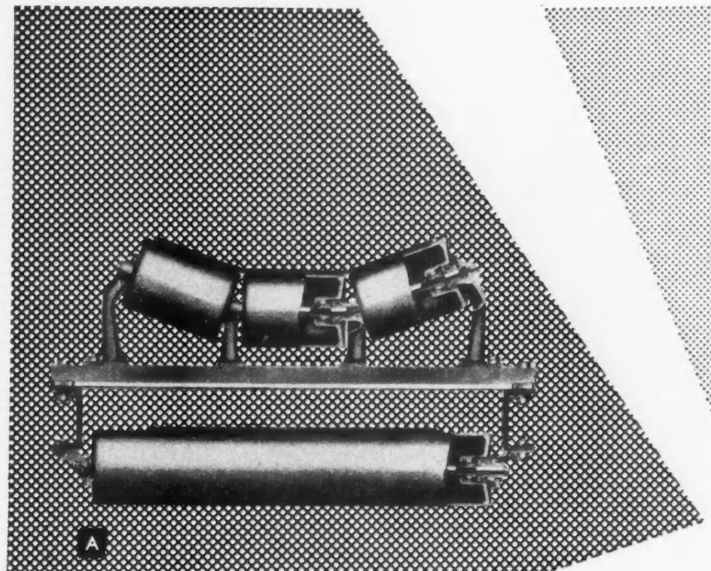
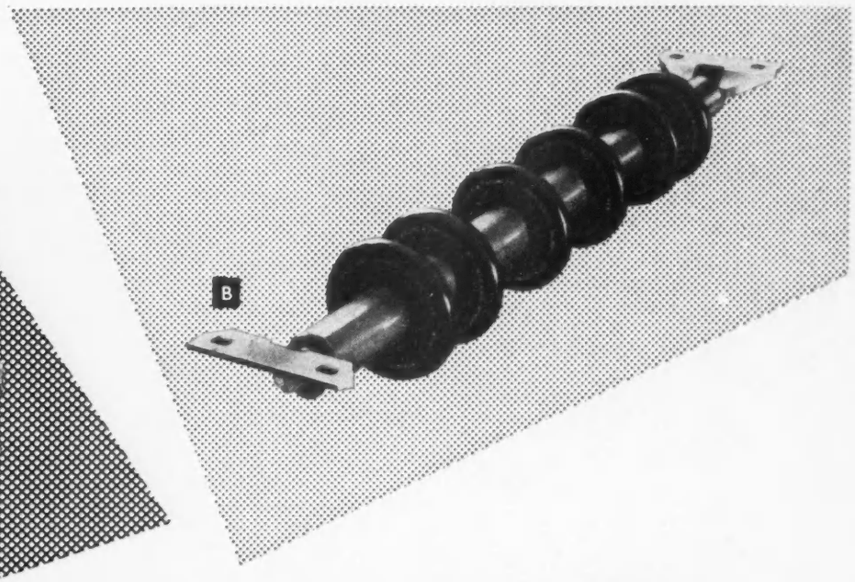
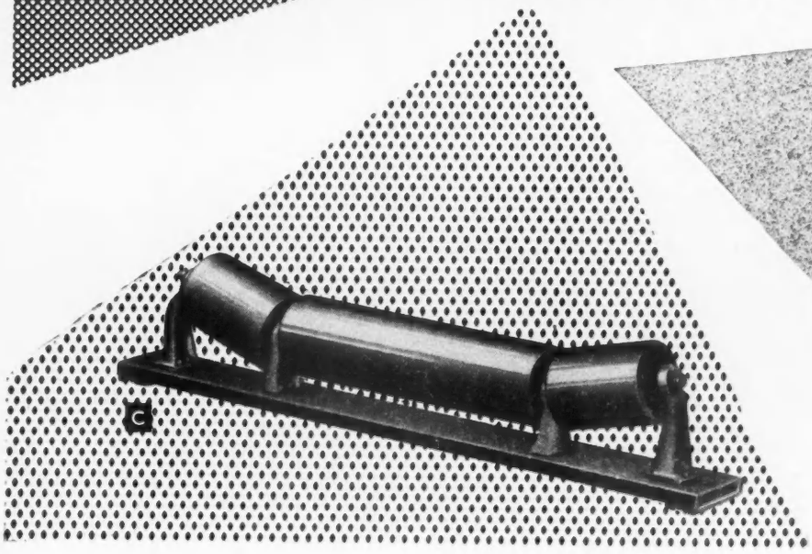
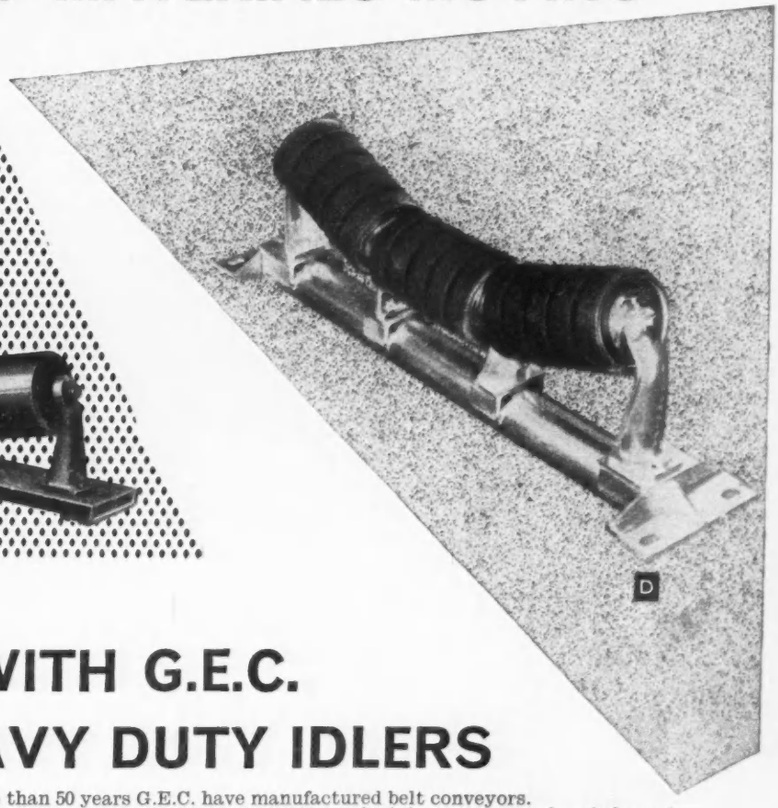




KEEP MATERIALS MOVING





A *6″ diameter steel tube troughing idler and return idler.* Rollers are made from mild steel tube 6″ outside dia. and 6 s.w.g. Strong, rolled section steel idler base board. All troughing idlers, except on reversible belts, provided with tilting blocks to aid training of the belt.

B *7½″ diameter rubber disc return idler.* Tube carrying discs is solid drawn 6 s.w.g. and 3″ outside dia. Discs are strengthened internally with mild steel ring and remain rigidly in position. Idler especially suitable where damp and sticky materials are handled.

C *6″ diameter steel tube feeder idler.* Rollers are mild steel tube 6 s.w.g. and 6″ outside dia. Contour of idler is designed so that material can be drawn freely from hoppers, etc., in relatively large quantities at low speeds.

D *6″ diameter rubber disc impact idler.* Tube supporting discs is solid drawn ¼″ thickness and 2½″ outside dia. Idler base board is constructed for exceptionally arduous duties. Discs are designed to support and protect belt at loading points, cushioning shock when impact is severe.

...WITH G.E.C. HEAVY DUTY IDLERS

For more than 50 years G.E.C. have manufactured belt conveyors. Shown above is a variety of heavy duty idlers which have been developed through extensive research and 50 years' experience in the materials handling field. Important features of these idlers are—

SEALS designed to retain lubrication and exclude dust and abrasive matter—thus reducing friction and wear.

BEARINGS of a taper roller type capable of a continuous load of 1,500 lb., giving a high factor of safety.

SINGLE SHOT LUBRICATION on either outside bracket. All bearings need only infrequent lubrication.

BRACKETS cast from malleable iron, designed for maximum strength and resistance to shock loads and breakage.

All components are proportioned to allow for corrosion, abrasion and normal abuse. Special equipment can be supplied to meet abnormal conditions.

For further information write for Publication No. 2829

G.E.C.

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THE GENERAL ELECTRIC CO. LTD. OF ENGLAND
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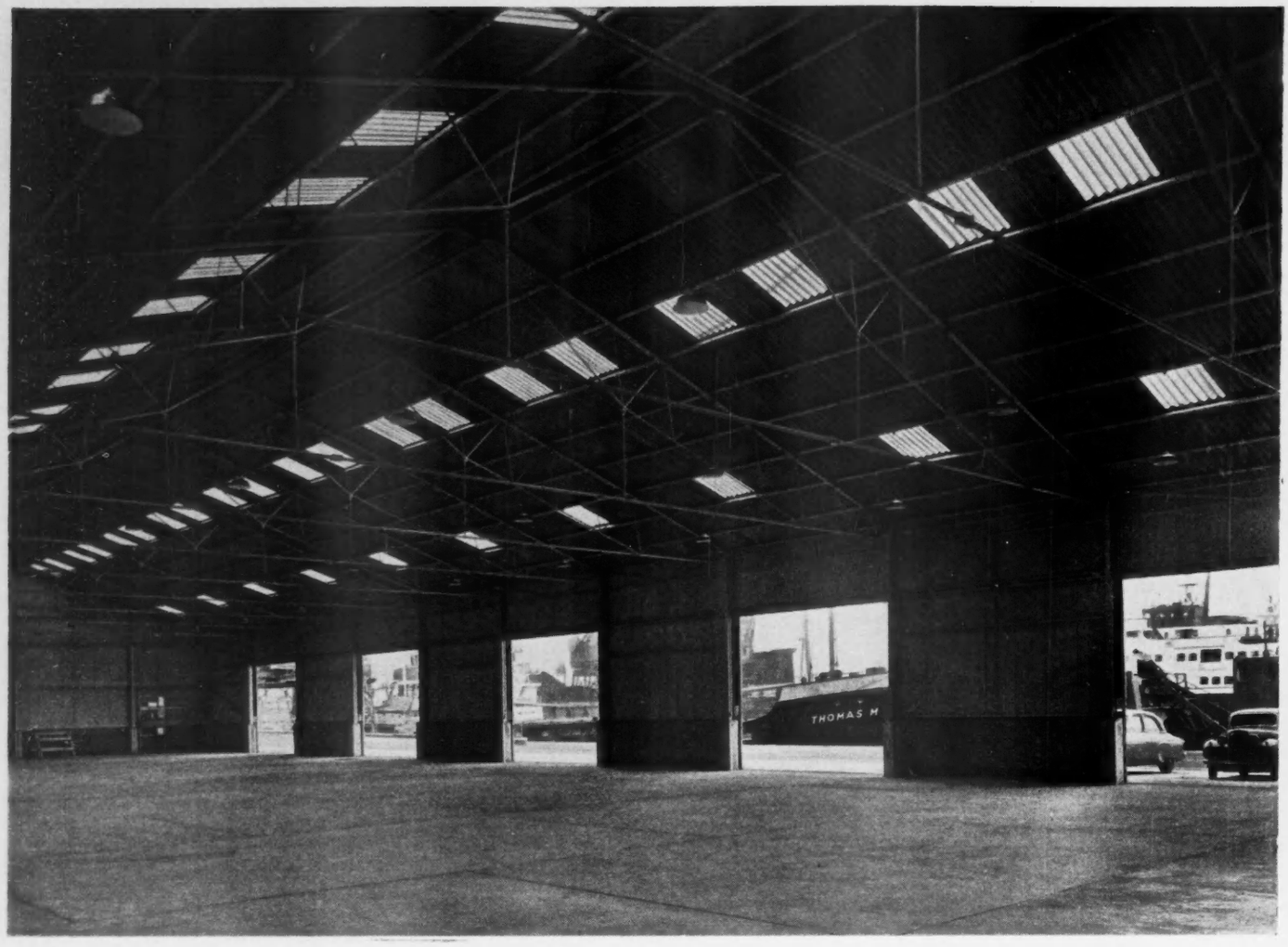
Designers and Manufacturers of Complete Materials Handling Plant.



'Arcon' 75 foot span transit building supplied by Taylor Woodrow (Arcon) Ltd., for Dover Harbour Board, Dover, Kent, in which Clear Corrugated 'Perspex' sheet, type 568, has been used for the roof lighting. Consultants: Coode & Partners.

Corrugated 'Perspex' for efficient roof lighting throughout the world

'Arcon' 66 ft. 8 in. span factory building supplied by Taylor Woodrow (Arcon) Ltd., for Bush Radio Limited, Plymouth, in which Clear Corrugated 'Perspex' sheet, type 568 has been used for the roof lighting. Architects: Ful'er, Hall & Foulsham.

CP.167

TAYLOR WOODROW (ARCON) LTD., supplied these buildings for the Dover Harbour Board and Bush Radio Limited; in both, the consultants specified Corrugated ' Perspex ' for the roof lighting.

Corrugated ' Perspex ' is inexpensive to install. It saves money on artificial lighting, and lasts indefinitely. It is tough, yet light and easy to handle. Corrugated ' Perspex ' is unaffected by the severest weather and withstands the corrosive atmospheres of industrial and marine areas.

Corrugated ' Perspex ' is available in a wide range of profiles to fit most corrugated roofing materials. If diffused daylight is desired, Opal Corrugated ' Perspex ' is available.

It's as clear as daylight—it must be

CORRUGATED 'PERSPEX'

'Perspex' is the registered trade mark for the acrylic sheet made by I.C.I.

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How they use *R·H·S*

For Gas Stoving Ovens

Darenth Engineering Industries Ltd., Erith, Kent

Our photograph shows the construction of a gas stoving oven produced by Darenth Engineering Industries Ltd. The framework is of R.H.S. which have to be cut to size and welded. Not only do their flat sides make possible a neat welded structure but they also provide a construction which is flush with the panels lining the ovens.

Rectangular Hollow Sections (R.H.S.) are now being used for a wide range of mechanical and structural purposes. The sizes available in the Stewarts and Lloyds' range of hot-formed sections are listed in the accompanying table. R.H.S. eliminate the need for special shaping of components before welding. Any straight-cut R.H.S. or tube will fit accurately against their flat sides whether square-on or at an angle and, moreover, lugs of various kinds produced from tube or bar are easily attached. Welding is simple and no bevelling is necessary.

Our subsidiary, Tubewrights Ltd., of 25 Buckingham Gate, London, S.W.1, is willing to advise on or quote for any welded sub-assemblies.

STEWARTS AND LLOYDS WAREHOUSES THROUGHOUT THE COUNTRY STOCK R.H.S.

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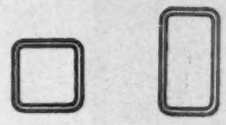
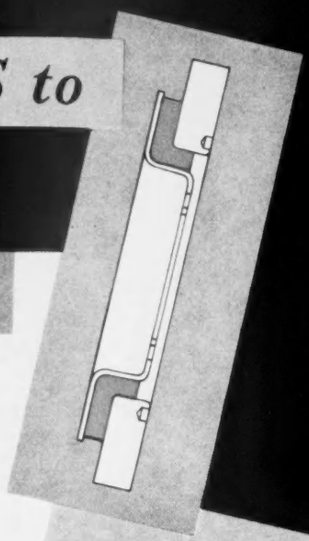


FROM	FROM
1″x 1″	1⅞″x 13/16″
TO	TO
5″x 5″	6″x 4″

R.H.S. ARE PRODUCED TO THE PHYSICAL PROPERTIES OF B.S. 1775 GRADE 16

STEWARTS AND LLOYDS S&L RECTANGULAR HOLLOW SECTIONS TUBEWRIGHTS

Bringing SMOOTHNESS to POWER



Prime movers are apt to transmit vibrations of one or more kind to their surroundings.

Torsional vibration can be reduced to a negligible quantity with the extremely simple Metalastik T.V. damper. Tailored to suit individual engines and sensitive to vibrations of the smallest amplitude, it permits a higher range of r.p.m. without detriment. Metalastik's unrivalled experience in analysing torsional vibration and designing dampers ensures success.

Out-of-balance forces, even with the best of engines, are often noticeable and here the patented Metalastik Cushymount and Cushyfoot 'S' mounting are of the greatest value. Cushymounts are ideal for the isolation of low-frequency vibration from diesel locomotive engines, large marine generators and other heavy machinery. Loads up to 5 tons per mounting are permissible and despite high deflections (up to $\frac{3}{4}$") no separate buffers or control links are needed. An adjustable buffer which limits excess movement is incorporated.

The Cushyfoot 'S' mounting is for the light-weight, four-cycle, high-speed diesel coming into general use on locomotives and is particularly suitable for the diesel-hydraulic. It provides a deflection of 0.25" under a load of 2,500 lb. and accommodates shunting shock loads up to 5 g. Adjustable buffer is incorporated.

For resonant torsional vibration in the marine engine/propeller-shaft system, the patented Torque Transfer coupling is an effective and economical solution providing, initially, a very low stiffness with a much higher value for a pre-determined torque.

The coupling illustrated, for one of the new Ruston & Hornsby marine engines developing 1000 b.h.p. at 435 r.p.m., is only 45" in diameter and $7\frac{1}{2}$" in width. At 6,000 lb. ft. torque, the torsional deflection is $7\frac{3}{4}$".

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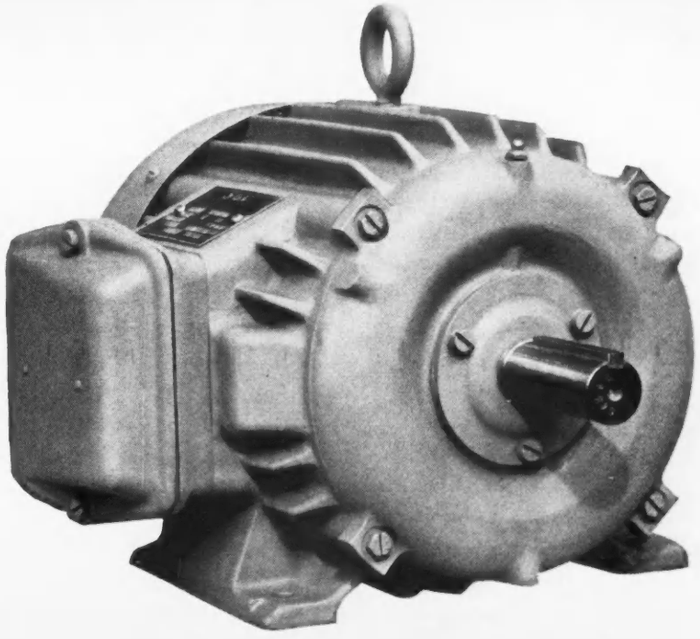


BY G.E.C.

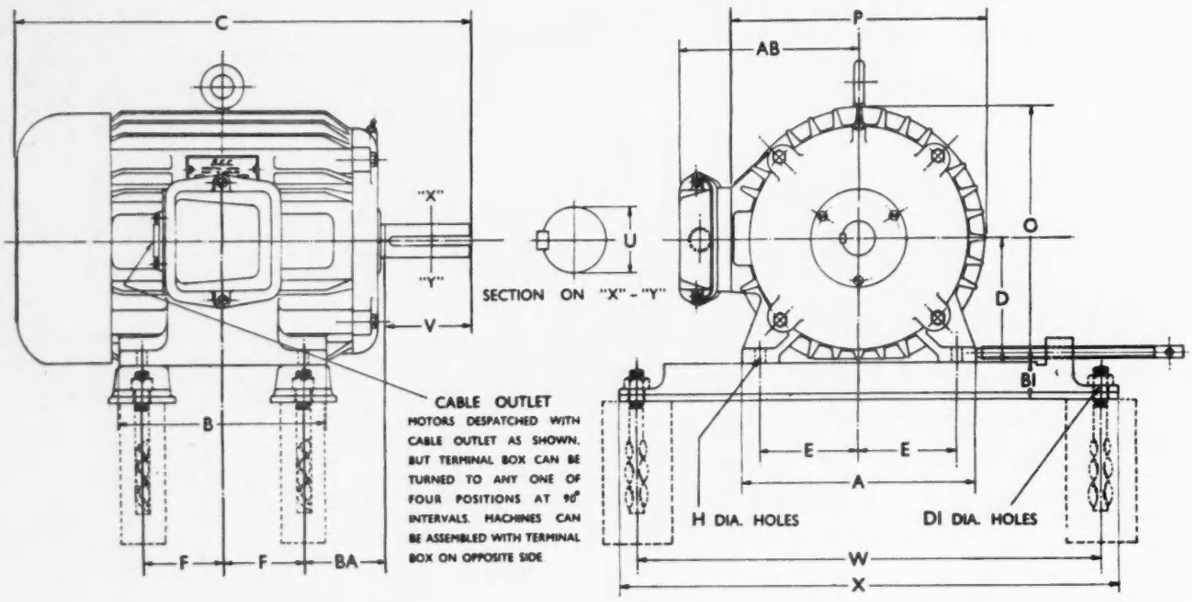
FOR RATINGS AND DIMENSIONS SEE OVERLEAF ▶

345

The new squirrel cage motors

(with class 'E' insulation)

RATINGS AND DIMENSIONS



H.P.		Frame Size	Frame											Shaft Extension		Slide Rails			
1,500 r.p.m.	1,000 r.p.m.		A	AB	B	BA	C	D	E	F	H	O	P	U	V	W	X	BI	DI
1	½	D162	8	6½	5¼	2¾	13 5/16	4	3⅜	2	⅜	8 1/16	8⅛	·7500	2¼	20 3/32	21 21/32	1 9/16	¾
1½	¾	D164	8	6½	6¼	2¾	14¼	4	3⅜	2½	⅜	8 1/16	8⅛	·7500	2¼	20 3/32	21 21/32	1 9/16	¾
2	1	D182	9	7 1/16	6	2¾	14¾	4½	3¾	2¼	7/16	9 1/16	9⅛	1·1250	3	20 3/32	21 21/32	1 9/16	¾
3	2	D184	9	7 1/16	7	2¾	15¾	4½	3¾	2¾	7/16	9 1/16	9⅛	1·1250	3	20 3/32	21 21/32	1 9/16	¾
5	3	D213	10⅛	7⅞	7½	3½	18 9/32	5¼	4¼	2¾	7/16	10¾	11 1/32	1·3750	3¾	20 3/32	21 21/32	1 9/16	¾
7½	5	D215	10⅛	7⅞	9	3½	19¾	5¼	4¼	3½	7/16	10¾	11 1/32	1·3750	3¾	20 3/32	21 21/32	1 9/16	¾

for further details, please write to:

G.E.C.

THE GENERAL ELECTRIC CO. LTD. OF ENGLAND

ROTATING PLANT DIVISION, WITTON, BIRMINGHAM 6
Telephone: EASt 1941 Telex: 33 - 323
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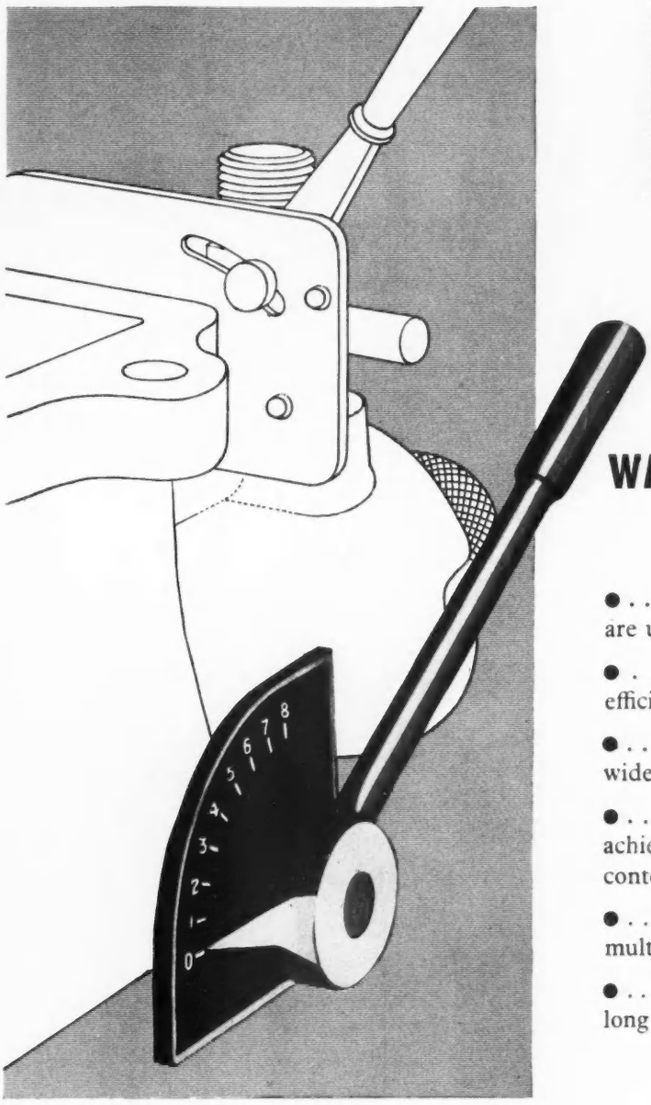

The Burner shown has a maximum output of 12 gallons per hour and requires atomising air at 20" (51 cm) w.g. to 30" (76 cm) w.g. with oil at not less than 5 lbs per sq. in. (0.35 kgs. per sq. cm.) or equivalent head.

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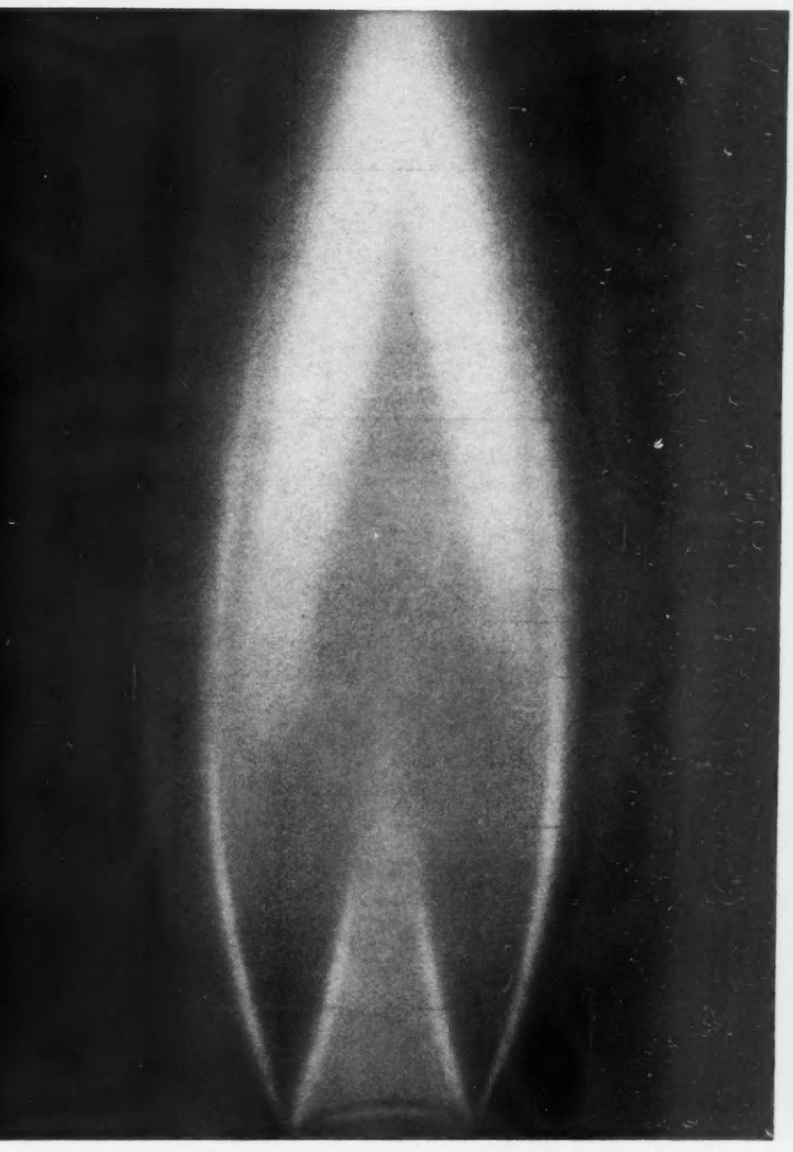

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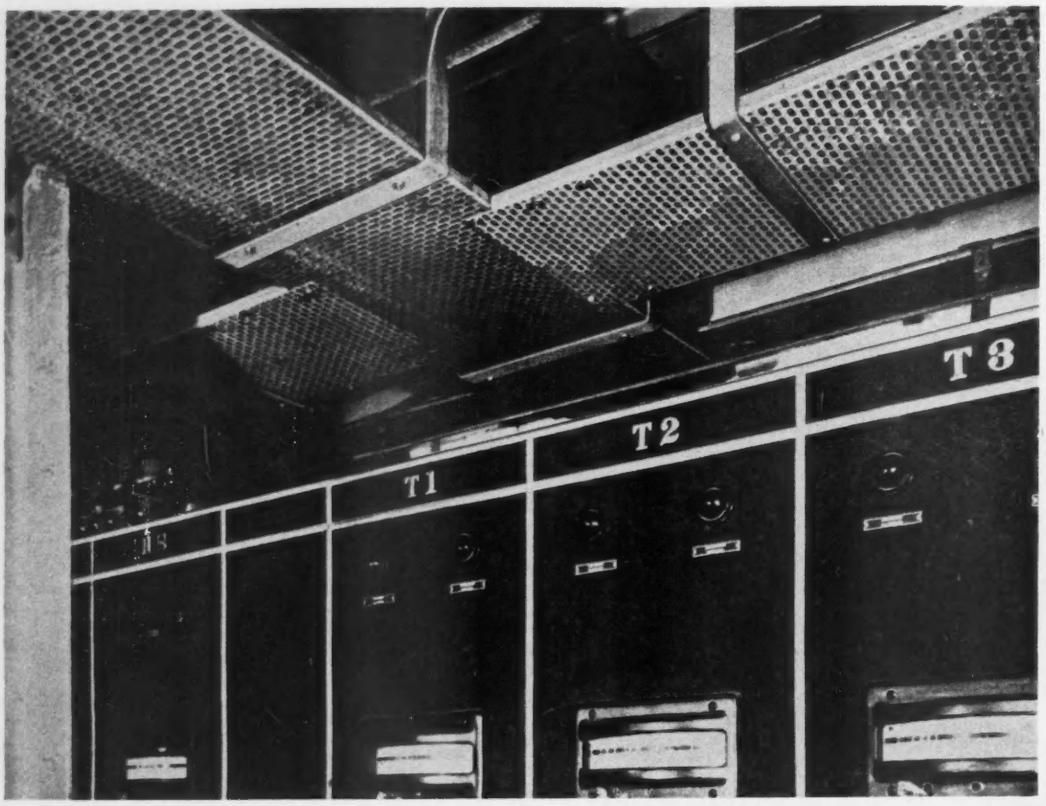

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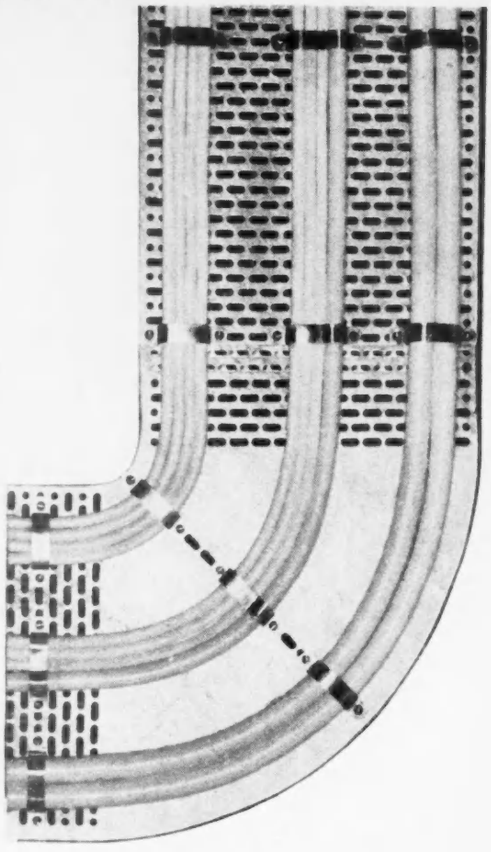

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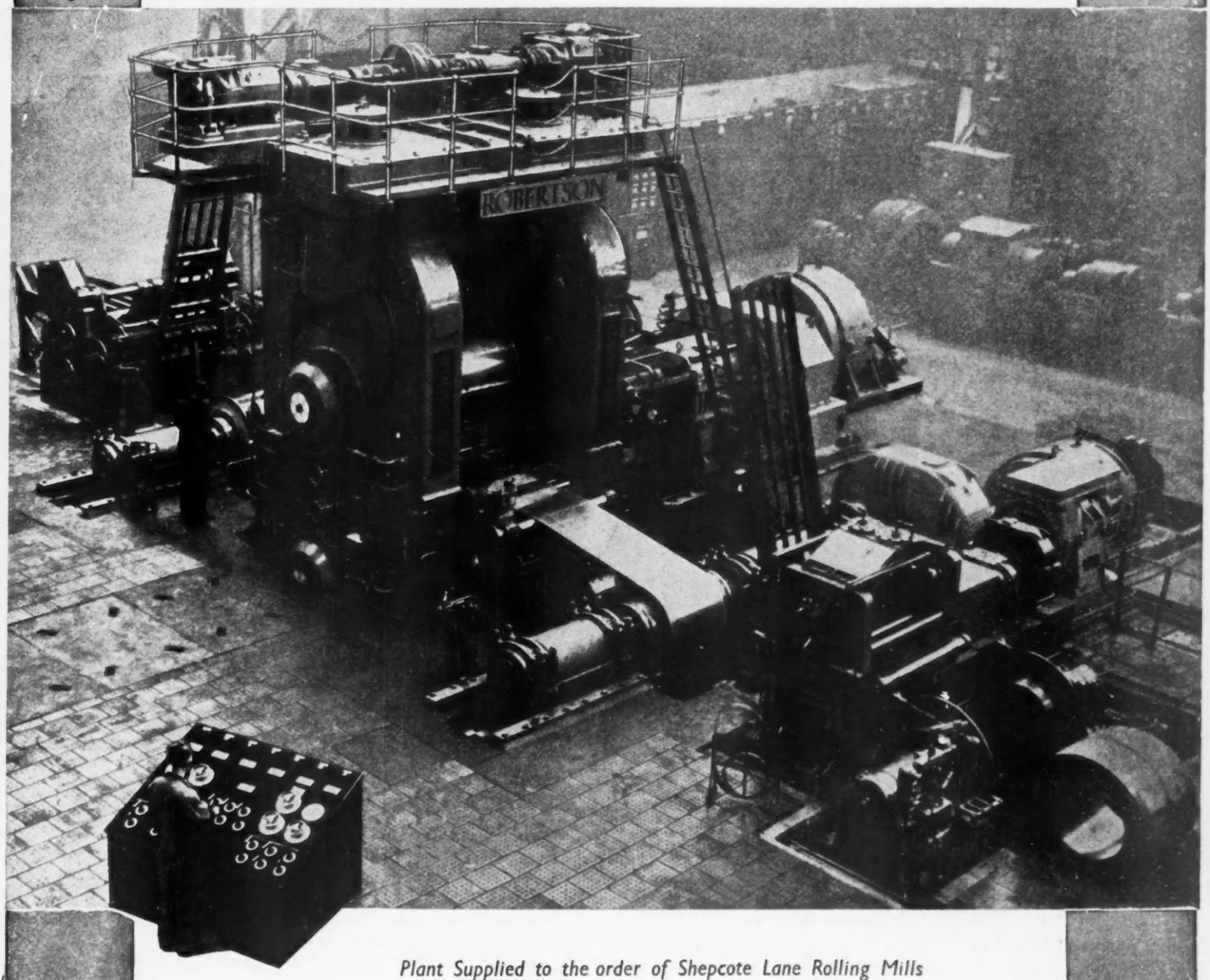

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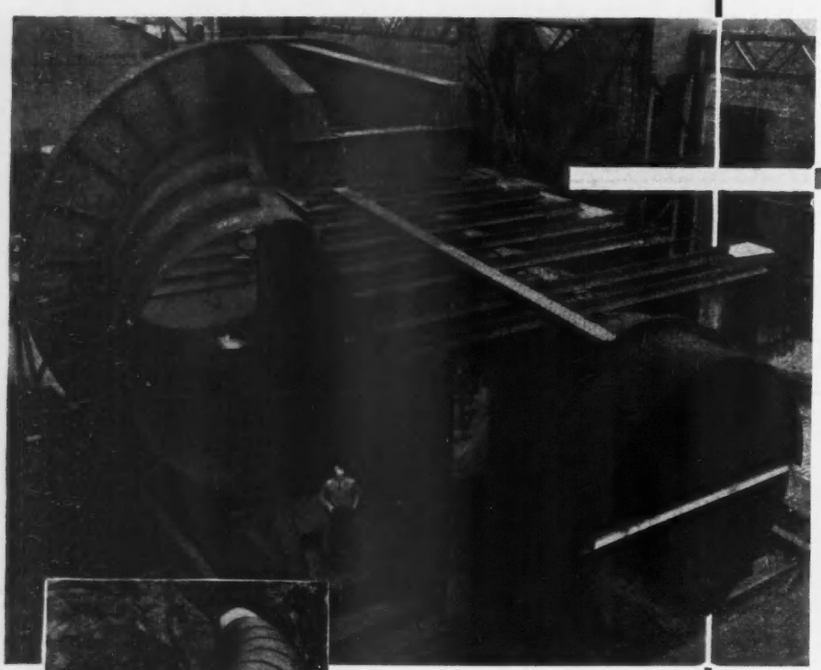

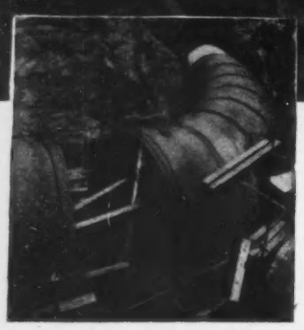

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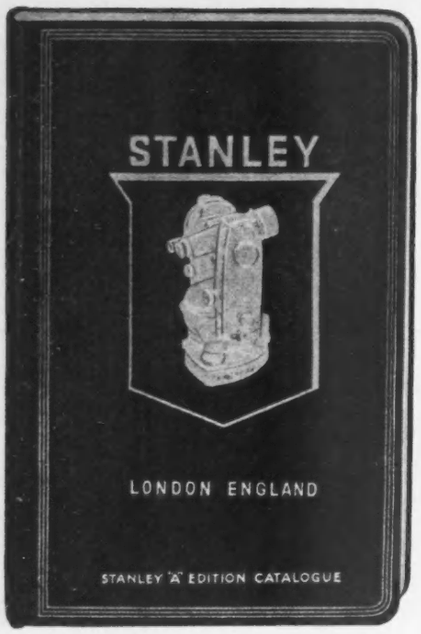

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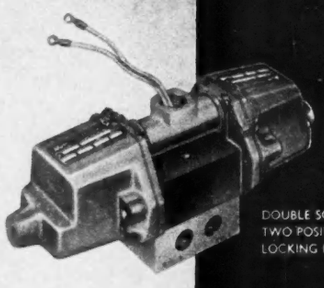
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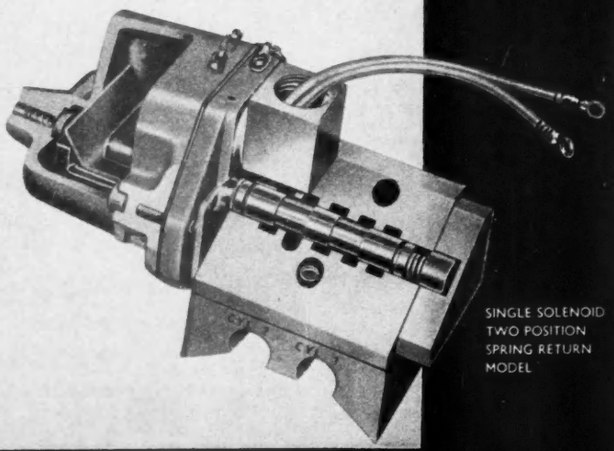
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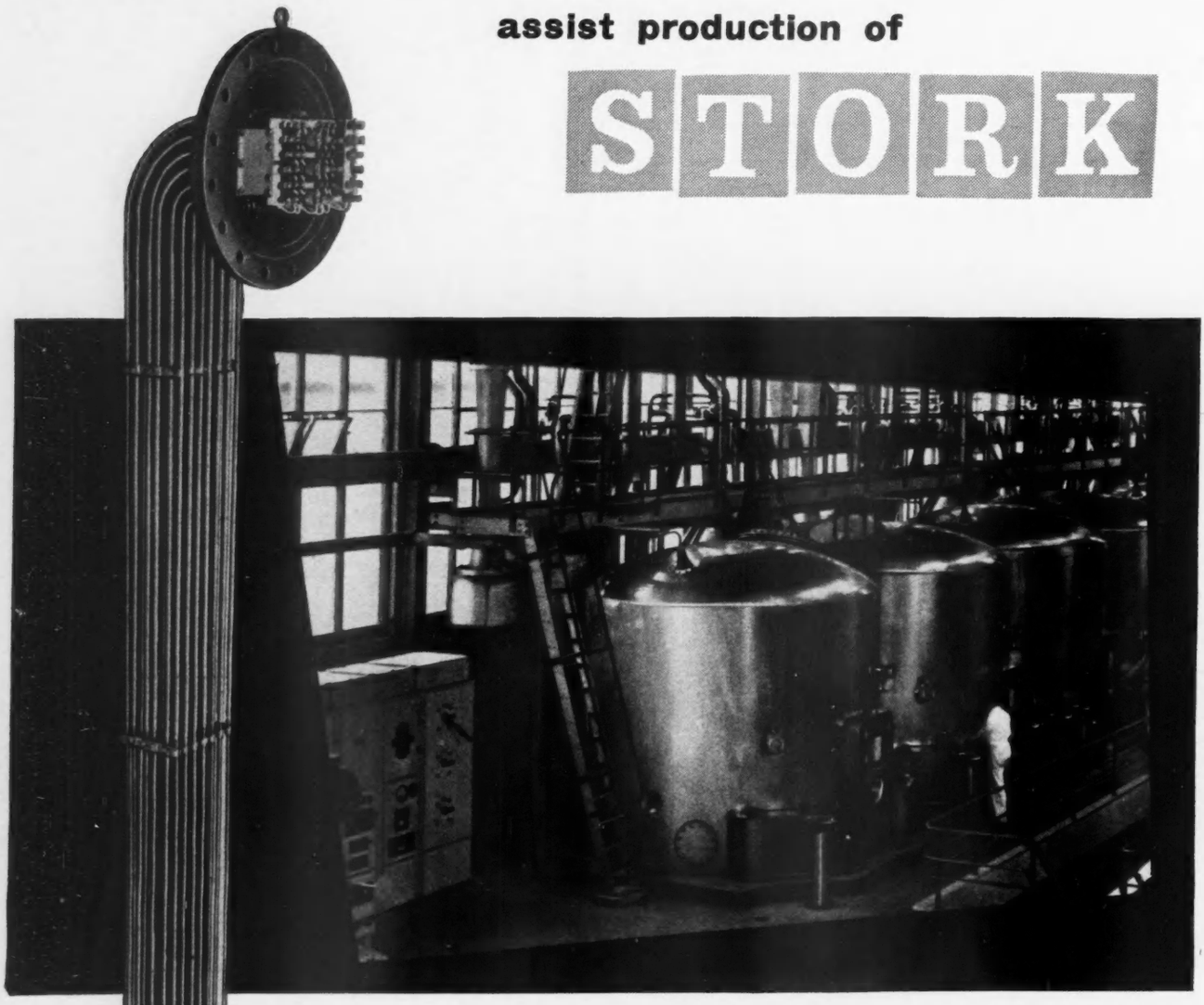
STORK



Processing vessels for edible oil used in the manufacture of 'Stork' margarine at the Bromborough Port Cheshire plant of Messrs. Van den Berghs and Jurgens Ltd. Each tank is heated by five of these 50 kW AEI immersion heaters.

AEI Industrial Immersion Heaters are highly efficient for a wide range of applications involving the heating of gases, liquids and solids. The tubular sheathed elements can be supplied preformed to the particular application or in straight lengths for bending by the user to suit his individual needs. Sheaths are available in different metals selected to withstand high temperatures and corrosive attack. In all AEI Industrial Heating Elements robust construction and special insulation ensure high mechanical strength and long working life.

Associated Electrical Industries Limited

TRANSFORMER DIVISION — HEATING & WELDING DEPARTMENT

Trafford Park - - - Manchester 17

ENGINEERING Impact

of Management Decisions Upon Research

Research is too serious a matter to be left to the scientists.

Thus Lord Nelson, chairman of English Electric, in his paper "Management of Research" read a week ago in Australia to the International Congress of Scientific Management. Well, is it?

Lord Nelson gives two examples and in doing so allows one of those rare glimpses of the chief executive in action, making the decisions that shape industry and the nation's trade.

The first illustration dates back to 1930 when the then Mr. George Nelson took over English Electric. The decision had already been taken to abandon diesel engine production because it was not thought the volume of business would pay the research and development costs. Convinced that the value of the diesel for power units of limited size was about to be recognised the new chief reversed the decision. What diesel engines mean to the English Electric group and their exports today needs no elaboration here.

The second example was negative. The company was spending a lot of money on research into high tension direct current transmission. This was certainly scientific research, but the Central Electricity Board had adopted alternating current as standard. Since it appeared to the new chief that there would not be enough business in direct current transmission for 30 to 50 years he cancelled work in this branch of research.

Now, thirty years later, the company is again investigating aspects of high voltage transmission of power by direct current with a programme which stretches many years ahead.

Should Small Firms Do Research at All?

Perhaps the small company which thinks it will help itself and others by setting up a small research laboratory of two or three graduates is wasting the scientists' time and its own money?

Lord Nelson explored this possibility and referred to the vast amount of scientific work going on in all parts of the world. Because of the expense and the shortage of first class technical brainpower it was essential to avoid waste and duplication.

The small company might find its money better spent in keeping abreast of the research laboratories by having a qualified man on the staff to study the technical literature and keep in personal contact with universities and Government research centres.

An obvious advantage of this would be that the great inflow of information, from the technical Press and other sources, would also be properly sifted and circulated to those concerned.

Since the research scientist is well known to work best in a laboratory where he has reasonable contacts with other men of like academic discipline, where original work is being published and where the leader is a man of professional standing, the small company might find that even if it was able to keep its two or three men their value would steadily decline.

It may be that companies who do not want to feel entirely dependent on what they can pick up from published work and other "open" sources could combine to form joint research subsidiaries, thus maintaining their independence but achieving the size and scope to keep a research organisation of worthwhile proportions actively at work.

Men Going Abroad

Be prepared for a greater number of engineers going abroad on short-term contracts. Dr. Charles Hill, who is the Cabinet Minister responsible for Government information services, said at the Institution of Locomotive Engineers' lunch last week that in the underdeveloped countries there is a great "hunger for expertise." We, he said, are exporters of skills. In the same week, Lord Chandos declared that training should be given to British people going abroad to prepare them for the political and emotional background of the new countries.

In place of the public school type who became a tea planter in Ceylon, today's representative of Britain abroad is more often a professional man who has given little thought to the social graces. As the school leaving age is raised this country will develop a larger reservoir of professional and craft ability. More and more of these men may be "exported" on short-term contracts, in place of exports of machinery.

There are two snags. Of all the boys going through our system of universal education, only about 10 per cent are allowed to think they are clever. The rest join the great herd of the docile, though many of them could give help overseas if their self-esteem was restored and they were given some of Lord Chandos's training.

Secondly, there is precious little guarantee that on his return to Britain the man who has done a good job for four or five years helping a new country will be eagerly sought after. Methods of overcoming this difficulty are being explored.

Propelling a Space Observatory

It seems likely that if British astronomers, engineers or physicists are to whirl around the moon or even the earth in space vehicles they will do so as passengers of the Americans. Unless they are able to get an invitation from a Soviet contact.

But it may be their vehicle will be thrust on its way by a British engine. Bristol Siddeley have now announced their Project "X" engine, specifically designed for satellite propulsion.

Project "X," a rocket engine, has the enormous thrust of 420 lb per lb (of propellant) per second but even so the complete launcher would have to carry 108 tons of liquid oxygen and liquid hydrogen.

If the satellite is to have a "precision orbit" its direction must be controllable at all stages in the launching. With Project "X" this is achieved along the same lines as with the Bristol Siddeley Gamma rocket engine used in the Black Knight re-entry vehicle.

The Project "X" wastes no space; reaching a maximum thrust of 100,000 lb it has a weight without fuel of only 1,420 lb and is 95 in long and 72 in in diameter.

of Guillebaud and the BTC's Engineers

It is one of the ironies of the British Railway's employment of corporate engineers that it is only the shameful fact that almost half of them earn less than £985 a year which brings them within the range of the salaried staff and therefore makes them subject to a recommended 10 per cent increase in pay by the Guillebaud report.

Those in the railway's employment who earn above this—and only the more successful can rise to the not so giddy heights of district engineer with a salary between £1,750 and £2,250 a year—were not directly affected.

But they are concerned in one indirect and another very direct fashion. If, as the result of Government decision and negotiation with the unions, the salaried staff receive the full 10 per cent increase proposed then it will obviously raise the level of men now earning just below £1,000 a year above the salaries of those immediately above them. They will also have to be increased and so the 10 per cent will be reflected much further up the line.

A much more important conclusion may be drawn from the reasoning of the Guillebaud report.

It proposes for some categories of railway employee that since their pay is "out of line" with other railway earnings, and including the already suggested increases, a rise of 18 per cent would be right in setting up the simplified pay structure.

There can hardly be another group of men on the railways whose pay levels are more out of line than the engineers. Reaching the successful position of district engineer will not carry a railway engineer more than a little beyond the level of the average for graduates employed in industry.

Boldly applied the Guillebaud report could be part of the establishment of a railway system with high morale, real efficiency and a proud place in the nation's esteem.

Sir Brian Robertson has shown how near this could be. Speaking on the day the report appeared to the annual lunch of the Institution of Locomotive Engineers, the BTC chairman said that in the period from mid-1960 to mid-1961 four particular electrification schemes would be completed—and modernisation would then begin to be seen to be really paying off.

The engineers on whom the modernisation plan, of the railways depend can only be neglected by the Transport Commission at the peril of all their schemes. This is a section of their staff who need at least an 18 per cent increase.

Disagreements on Development

The path of the planner is beset by controversy, especially when it is industry that is being shaped.

From Leicester and from Sheerness dockyard come the sounds of local opinion clashing with decisions of the Board of Trade. At Sheerness an industrial development firm, Building Developments Limited, is establishing the former naval base as a port and industrial estate. There is naturally a pool of labour which will benefit from their efforts and which will itself benefit the companies who move in and use it. Something like consternation arose when it was learnt that the Board of Trade has refused licences to two firms, which would each employ 1,000 people, who want to move into the area. The Board appears to have given as the reason that labour would not be available.

At Leicester there is trouble over relocation of industry moved out by slum clearance. A city with a diversity of occupations, Leicester has long had a history of low unemployment. Now the Board of Trade has declined a certificate to allow a large firm moved from one Leicester site to go to another in the city.

Local trade interests have calculated that almost 300 firms may be similarly affected. Their total present labour force is just over 4,400 people. The claim of one dissident, that Leicester is in danger of becoming a distressed area, may be pitching it a little too strongly.

What is inescapable is that persuading, or even by negative action compelling, industry to move from low unemployment areas to those where the proportion is above the national two per cent, can be painful. At the worst it can bring areas below the average for unemployment up to that proportion. At the least it will cause some people to move home in pursuit of their jobs.

and Providing Money for Medium Firms

Vacuum analysers, electric resistance furnaces, robot controlled sterilisers, ten-ton rear stearing semi-trailers: these are only a few of the products from the engineering firms who have been helped by capital from the Industrial and Commercial Finance Corporation.

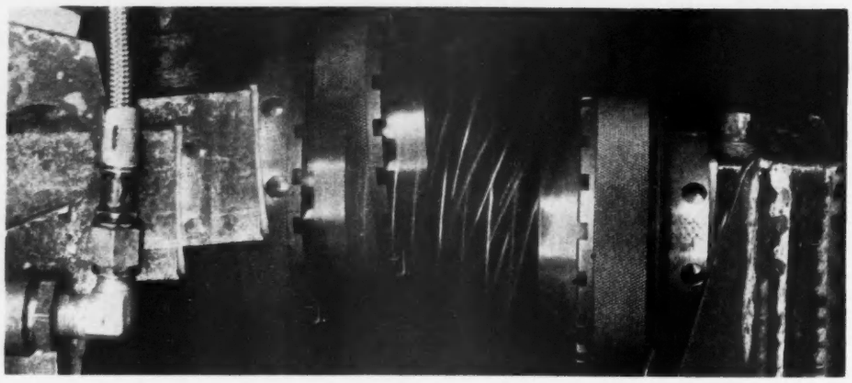
Where there was once something like a vacuum between the top limit of a few thousands that the banks loaned on overdraft and the multiples of £100,000 raised on the Stock Exchange from the private and public investor, there now stands the ICFC, devoted to the task of providing the money needed for the expansion of the smaller and medium companies.

From its founding in 1945, by the English and Scottish banks at Government inspiration, the Corporation has invested or lent almost £65 million to a thousand companies spread through 50 industries. In assesing a proposition, the Corporation's staff take the line that the backbone of an undertaking are its people. It is specifically not concerned with having a finger in the detailed management of an undertaking. Its aim and achievement is to put capital, at market rates, into companies who, without its help, would be slowed up, or prevented from developing new products or broadening their activities.

Of the Corporation's investments and loans, up to April last year, 23 per cent had gone into engineering industries. Within those industries, electrical engineering had absorbed 18·7 per cent of the ICFC's total, machine tools 3 per cent and agricultural machinery 2·2.

Ptfe Lined Pipes and Flexible Couplings

Production techniques can make or mar ptfe mouldings. Addition of carbon black during processing allows one firm to extrude thin walled tubing and to make a range of high performance couplings.



Bellows in ptfe undergoing flexing testing with internal fluid pressure.

Du Pont's brand of ptfe, called Teflon, was introduced more than ten years ago. It was soon realised that a material so chemically inert and thermally stable was almost as inert to the conventional processing techniques used for other plastic materials. Since the viscosity above its melting point was about one million times greater than other thermoplastics it did not exhibit the characteristics of plastic flow in its molten condition, and, since there was no known solvent for Teflon, it could not be dissolved. Other techniques had to be developed which somewhat resembled those used with ceramics.

Teflon is completely unaffected by all chemicals except molten alkali metals, and free fluorine at elevated temperatures and pressures. It is the most thermally stable organic compound known having a continuous useful temperature range from − 72° C where it is still flexible, to 260° C. Even at a temperature as low as − 238° C it still has some elongation. It can be used for shorter periods in certain instances up to its crystalline melting point of 326° C where its rate of decomposition is only 0·0003 per cent per hr. A decomposition rate of 0·5 per cent per hr is not reached until around 480° C.

It is not true, however, that the fabricator need just purchase the resin, some basic equipment, and set up his business. The physical characteristics of the final product can vary considerably, depending upon many factors such as variations in the basic resin production procedures, and processing conditions.

The fabrication of Teflon starts with virgin Teflon granular powder. This powder is first compressed into the desired form, followed by a baking or sintering cycle at temperatures above its melting point. The particles in all ptfe granular moulding and extrusion powders of different particle sizes have feather-like fingers extending from their surfaces. In order to obtain the density necessary for achieving optimum physical properties, the particle size and shape must be carefully controlled, and a critical pressure must be applied uniformly throughout the entire cross-section of the preform.

If the die cavity is not uniformly shaped, or if insufficient pressure is exerted, the matrix will be opened, resulting in final porosity. If excessive pressure is applied, a shearing action may occur between charges, resulting in fine cracks or cleavage planes in the final fusion. For these reasons, most complex or unsymmetrical shapes are generally best fabricated by machining them from the simpler forms, such as sheet, rod, or tube all having uniform cross-sections.

Such factors, coupled with the high bulk density of the ptfe powder, generally limit extrusion of tubes in the relatively larger sizes required for lining pipe to heavy wall thicknesses averaging about $\frac{1}{4}$ in. Despite the fact that three different types of ptfe powders have been developed, all attempts to extrude walls thinner than about $\frac{1}{4}$ in down to approximately $\frac{1}{16}$ in, in pipe sizes of 1 in and larger, have been only partially successful due to intermittent porosity.

A process patent issued to Resistoflex contends that more uniform extrusions with high strength, ductility, and flex life can be made by incorporating a very small amount of carbon black into the lubricated compound. The net results are far more uniform products of consistent density with usually twice the tensile and compressive strength, ductility, or flex life than can be obtained by conventional processes. These products are designated by the compound number Fluoroflex-T1001.

Now that a suitable material for lining pipe was developed, another major obstacle had to be overcome before success could be achieved. That lining had to stay locked inside the pipe over a wide range of process temperatures, and in order to lock the liner in place, some means of overcoming the thermal expansion difference of approximately ten to one between the ptfe liner and the steel pipe had to be developed. In the method used by Resistoflex, the liner is under controlled tension regardless of size or length. As the temperature of the process stream increases, all the way up to 260° C, the liner simply tends to overcome its inherent tension without elongation.

Reports from US Government laboratories showed an increase of 25 per cent in weight after immersion in nitric acid, and since this was completely contrary to the reported chemical inertness of ptfe, tests were carried out to determine why this was so. Two sheets $\frac{1}{16}$ in thick of moulded ptfe were used, the only difference between them being the amount of time and care exercised in distributing and levelling the powder in the preform moulds. It was shown that upon immersing the test pieces in a commercial penetrant dye for about 15 min, one sheet clearly showed porous areas, of various intensity (see illustration). Upon examining the specimens under a microscope it was found that the surface was covered with fine cracks and pores.

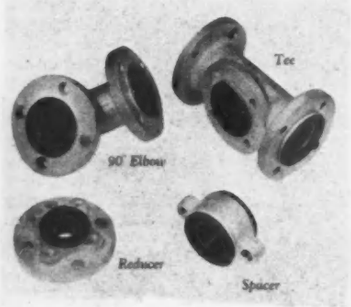
Although the tensile strength of ptfe is generally advertised as ranging from 1,500 to 3,000 lb per sq. in, it is found that non-porous samples meet the high values, whereas porous samples only meet the minimum figure 1,500 lb per sq. in. More important though is the fact that permeability and flex life vary as much as 1,000 fold. It is also found that the electrical insulation properties show vast differences between 600 V per mil in the non-porous samples, against approximately 200 V per mil in the porous sample. The normal value for ptfe is 400 to 500 V per mil. The difference between the normal value and Fluoroflex value is solely due to the fabricating controls.

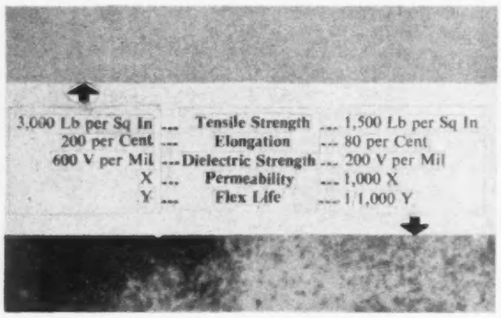
Although hosing can be made to suit individual conditions, Fluoroflex-TS is supplied as standard pipes consisting of schedule 40 or schedule 80 seamless carbon steel, in a variety of sizes assembled to order, with 150 lb ductile iron or steel flanges. In addition to piping, Fluoroflex comes in a complete range of fittings, including blind flanges, elbows, tees, crosses, reducing flanges and spacers such as are shown in the illustration.

Fluoroflex-TS dip-pipes are also manufactured in schedule 40 steel pipe, lined and flanged at one end with Fluoroflex-T, with the jacket extending up to the back of the connecting flange, the liner is formed back over the outside of the pipe making a lap joint with the jacket at the bottom end. This joint is mechanically sealed with a compression-swaged tantalum ring, to provide a liquid and gas-tight protective cover over the steel reinforcement.

Other items of interest made from Fluoroflex-TS are thermoweld baffles, laminated spargers (both plain and contoured) and chemical transfer hose. In the top illustration is a four convolute design of a bellows with spanner nut compression fittings instead of the standard two and three convolutes usually equipped with flanges.

This bellows is used on a current US Navy Jet Interceptor (Chance Vought F8U) as a flexible connection in the fuel line between the fuselage and wing where fuel tanks are located. In addition to the customary motion of airfoils on modern aircraft, the wing of this interceptor has controlled variable angles of incidence and attack, necessitating an extremely flexible connection in the 3 in line where the wing joins the fuselage. Extreme flexibility and toughness of the bellows are demanded during qualification




3,000 Lb per Sq In ... Tensile Strength ... 1,500 Lb per Sq In
200 per Cent ... Elongation ... 80 per Cent
600 V per Mil ... Dielectric Strength ... 200 V per Mil
X ... Permeability ... 1,000 X
Y ... Flex Life ... 1/1,000 Y

Left: Selection of lined fittings.
Right: Dye test reveals porosity.

Standard Resistivity for Aluminium

Four documents, the product of years of committee work, are now published by the International Electrotechnical Commission—the subject, aluminium conductors. These documents, numbers 104, 105, 111 and 114 are obtainable direct from the IEC at 1 Rue de Varembe, Geneva, Switzerland, or through British Standards Institution.

The most important of these four standards at the present time is No. 111: *Recommendation for the Resistivity of Commercial Hard-Drawn Aluminium Electrical Conductor Wire*, which lays a standard value and also a maximum value for hard-drawn aluminium wire as used in overhead lines with or without steel reinforcement. International agreement on a standard value of resistivity has long been needed because of the world-wide use of aluminium as an electrical conductor material. The standard value for the volume resistivity is 0·028264 ohm-mm² per m at 20° C and the IEC document states that this is the value to be used for the purpose of calculating resistances of conductor wire.

Publicaton No. 111 also lays down a maximum resistivity for the wires which coincides with the standard value and can be used for acceptance tests on material in a conductor. Values are also given for density, constant mass temperature coefficient of resistance per deg. C, and coefficient of linear expansion per deg. C. These constants are all required in calculating conductor resistances and conductor performance in various circumstances.

Publication No. 104, *Recommendation for an International Specification for Aluminium Alloy-Conductor Wire of the Aluminium-Magnesium Silicon Type*, lays down the maximum resistivity (0·0328 ohm-mm² per m at 20° C) for this type of alloy wire. Minimum strength according to the new recommendation is 30 kg per sq. mm (42,470 lb. per sq. in).

The resistivity of pure aluminium busbar according to publication No. 105, *Recommendation for Commercial Purity Aluminium Busbar Material*, is 0·0290 ohm-mm² per m. The last of these publications, No. 114. *Recommendation for Heat-Treated Aluminium Alloy Busbar Material of the Aluminium-Magnesium-Silicon Type*, lays down similar data for this alloy, which has a maximum resistivity of 0·0325 ohm-mm² per m at 20° C, a 0·2 per cent proof stress of not less than 17 kg per sq. mm (28·445 lb per sq. in), and a minimum tensile strength of 20 kg per sq. mm (24·450 lb per sq. in). This material is attractive to electrical engineers as it has similar mechanical properties to those of copper for busbars, and jointing with bolted connections is therefore simplified. One important purpose of this recommendation is to encourage use of only one type of material among the many of this group which can be readily produced.

Concluding Ptfe Lined Pipes

testing for full longitudinal, axial, and lateral deflection. This four convolute design provides the travel and flexibility for working pressure of 75 lb per sq. in, proof pressure of 150 lb per sq. in and a burst pressure of 300 lb per sq. in.

Here follow some examples of typical installations using Fluoroflex-TS pipe and fittings which are operating in the USA.

(1) 75 ft of 2 in diameter pipe with 15 fittings, for use with 50 per cent nitric acid at 179° C at 50 lb per sq. in in a continuous process: this plant has been running since May, 1958, and so far no failures have been reported. Ptfe was used to replace tantalum lined 304 stainless steel.

(2) 2,000 ft of 1 to 6 in diameter pipe with 500 fittings for use with a 20 per cent hydrochloric acid mixture of strong organic solvents at 135° C to 149° C at 80 to 130 lb per sq. in in a continuous process: plant has been running since March, 1957, with no reported failure to date. The Fluoroflex-TS replaced Hastelloy, glass-lined steel and Haveg piping.

(3) 600 ft of 4 to 6 in diameter pipe with 60 fittings for use with 20 per cent HF and 80 per cent water vapour at 110° C to 232° C in a continuous process. Installed in April, 1959, this replaced a Monel system.

This article is based on a lecture which T. R. Thierry, manager, technical sales and service, of the Resistoflex Corporation, Roseland, New Jersey, USA, gave in London by arrangement with BTR Industries Limited, the sole manufacturers of Fluoroflex in the United Kingdom.

Car Weatherstrip

These disconcerting photographs are of weatherstrip on European cars which had deteriorated during transit to showrooms in the USA.

Du Pont, who featured these in their *Elastomers Notebook*, suggest that their elastomers such as neoprene should be used on cars. Whatever the solution, this is not a good advertisement for European products.

Good Pipe Joints are Taped

This chemically inert material ptfe is causing quite a stir. The manufacturers, ICI Plastics Division, must be very happy, for engineers are beginning to hunt out new uses for it themselves. Take tape, a brand of which was announced in the issue of 19 February, p. 247, made by the Fluorocarbons Department of AEI; this was offered in sizes up to 2 in width and 0·015 in thickness. As is pointed out in the main Materials article this week and has often been stressed before, ptfe is inert to all chemicals except molten alkali metals and gaseous fluorine at elevated temperatures, and it is not often that any of these is met.

To what use can such self-adhesive tape be put? The ptfe division of Crane Packing who have explored most of the outlets for ptfe materials have come up with one—for sealing threaded pipe joints. For such use they append the name Thredseal to the tape and sell it at the moment in one size only at ½ in width in standard reels of 40 ft. Here the properties of ptfe show up well: a small amount of cold flow under pressure permits the tape to take up the shape of the threads and to conform with not very smooth surfaces. At the same time it will not gall or seize, so that with its low coefficient of friction, joints can easily be tightened and yet be broken down years later.

Crane Packing Limited, Slough, Bucks.

New Pvc Sheet Deep Draws Well

A new grade of thermoplastic pvc sheet is being marketed by Bakelite under the name Vybak DVR 262. The makers say this fills a " long felt need for a pvc sheet combining great toughness and excellent vacuum forming properties."

This material represents a new approach to the formulation of high impact strength pvc sheet in that it is produced entirely from pvc copolymers. It contains small quantities of stabilisers, lubricant and pigment but no plasticisers and the use of modifiers, which often lead to poor ageing characteristics, is avoided.

The new sheet has good dimensional stability and is capable of deep drawing with good detail. For instance, satisfactory vacuum formings have been made under the following conditions.

Conditions for Deep Drawing New Pvc Sheet

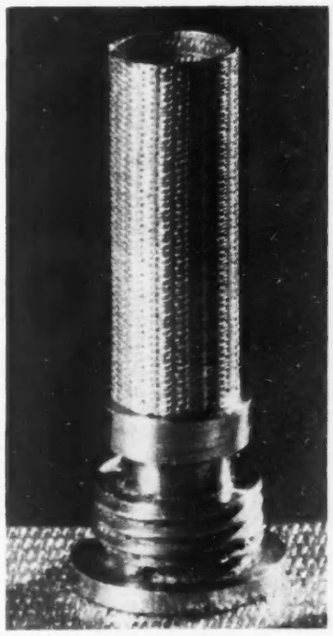
Sheet thickness, in	0·02	0·06	0·18
Sheet temp., ° C	60	65	90
Preheating time, sec.	25	35	150
Approx. mould dimensions, in	9 × 7 by 15 deep	14 × 13 by 6 deep	36 × 24 by 18 deep

The toughness and deep drawing characteristics of this sheet suit for applications such as refrigerator liners, trays, and industrial containers where the maximum temperature is 50° C.

Bakelite Limited, 12 Grosvenor Gdns, London, SW1.

Tough Filter Elements

A new filter material made by Sintered Products is tough—it therefore scores one mark over its powder metal companions. Called Rigimesh, it is produced in sheet form from the welding of several woven wire meshes together. The standard material is 18Cr-8Ni-stainless steel, but it can also be produced in Monel, Nimonic 75, nichrome, bronze and nickel. Porosity ratings are from 5 to 100 microns, but a rating of 2 microns can be made to order.



Inherently this material embodies the heat resisting and corrosion resisting characteristics of stainless steel. In the chemical industry Rigimesh is superseding centrifuges in the handling of excessively corrosive liquors. And it is to a great extent replacing ceramics and graphite in filtration units.

In the aircraft industry Rigimesh is used for the distribution of de-icing fluid on the leading edges of aircraft. Another application is its use in boundary layer control—a technique of vital and increasing importance to aerodynamics.

Sintered Products Limited, Hamilton Road, Sutton-in-Ashfield, Notts.

Plain Words

By Capricorn

LAMENT the passing of the chimney. Under our very noses it is disappearing from houses, from locomotives, from factories, and from ships (under the alias "funnel").

I can think of no other component which is so symbolic of engineering, such a bond between civil, mechanical, and electrical engineers. The civil engineer built it, the mechanical engineer produced the filthy gases that went up it, and the electrical engineer, in its power-station form, could claim it as the outward and visible sign of his brand of sorcery.

Like the wasting members of an animal in evolution, the house chimneys all over London are for the most part dead or dying. In banks and terraces like the houses they used to serve, they are the unwanted bequests of our Victorian grandfathers. They remind me of domestics carrying coal, of large families, and the household management of Mrs. Beeton.

Chimney? The word itself is inextricably buried in my subconscious along with early memories of shunting locomotives, the splendid noises they made when they were busy, and the pungent, drugging smoke that filled your nostrils as it was wafted by on the wind.

That smoke wasn't good for us—the Clean Air Act says so. Locomotive smoke and factory smoke and all the other smokes were bad for our lungs, so the tall chimneys are being felled like giant forest trees. The old landmarks in the Black Country are disappearing, with hardly anything new to take their place.

To railwaymen the old locomotive chimneys were more characteristic of their companies than were the coats of arms. Each company had its familiar shape of chimney until boilers got too big and streamlining came in. The original Royal Scots were perhaps the first sign of the rot setting in: that absurdly squat chimney on a fat smokebox had no hope of showing its shape. I suppose sailors could tell much from the funnels of a distant ship. When there were several tall funnels standing up at a jaunty angle like Brunel's top hat, down below in the engine room there were gleaming triple-expansion or quadruple-expansion engines.

There are still plenty of chimneys to be seen, of course, but take a good look at them because the time is coming when they will be as uncommon as horse-drawn carriages. Smoking chimneys used to be a sign of prosperity; now we know they were also signs of waste, a confession of failure to evolve efficient processes. Chimneys must go—chimneys dark and satanic, as in mills; chimneys pugnacious, as on the Royal Scot; chimneys misbegotten, as on houses that were troubled with smoke puffing into the room; and even chimneys romantic, as on Swiss lake steamers. Only one type remains and multiplies—chimneys horizontal, as on jet aircraft.

Letters to the Editor

Training African Engineers

SIR, Your article on "Engineer Training in the New Nations" (ENGNG., 26 Feb. '60, p. 287) very opportunely draws attention to a major problem in the development of "newly emerging" countries, but unfortunately gives an incomplete picture of our British contribution and of factors likely to affect such training in the future.

Much could be written, but, as a former professor in London concerned with this task in India and Nigeria during the last ten years, may I touch briefly upon the matter? My remarks are confined to African territories which are, or have been, under British protection. Khartoum is an exception in that engineering training was started at professional level in an institution already formed as a university college.

The official policy of the Colonial Office (through what is now known as the Council for Overseas Colleges of Arts, Science and Technology) was to develop professional technological education in such colleges alongside the University Colleges, and there resulted the Royal Technical College, Nairobi; the Kumasi College of Technology; and the Nigerian College of Technology. In Ghana and Nigeria, engineering professional training was instituted in the middle 1950's, and considerable sums made available from the pocket of the British taxpayer through colonial development and welfare funds.

The policy at first was to train students for the professional examinations of the Institutions of Civil, Mechanical and Electrical Engineers and helpful cooperation was received from them, although it was made clear by them that the mixing of sub-professional courses with those for professional engineers was not liked. The basic policy of the Nigerian College, for example, formulated in 1954, established in effect in Nigeria a College of Advanced Technology some three years before they were formally established in the United Kingdom. The Institutions' examinations were not acceptable locally for two main reasons: because it was considered unfair to deprive local students of the opportunity of gaining an engineering degree and because of the strong feeling that, in an African society, the non-graduate professional engineer would be at a disadvantage and his status uncertain compared with, say, an administrative official with an arts or science degree.

The courses for B.Sc.(Eng.), London, were instituted in Kumasi in 1955 and in the Zaria branch of the Nigerian College in 1956. It is, therefore, unfortunate that the article tends to imply that there were no degree courses in Nigeria before 1958 and that they have not yet started in Ghana. The engineering degree courses at Zaria are run under an arrangement somewhat analogous to that between the Manchester College of Science and Technology and the University, whereby the Faculty of Engineering of the University College is located in the Nigerian College, the students of the Nigerian College being registered also as students of University College at Ibadan 500 miles away, for the purposes of the special relationship with London University. My holding of the honorary Chair of Engineering in University College and the office of Dean, in addition to my office as Rector of the Nigerian College, facilitated the administration.

In East Africa, as far as I am aware, there has never been any intention of introducing engineering at Makerere College in Uganda, since its complementary College for East Africa, the Royal Technical College, in Nairobi, provides for engineering. Therefore, the facilities for engineering professional training in colleges sponsored by the Colonial Office in Africa (and elsewhere) are by no means as tenuous as could be inferred from your article.

What of the future, when the country has "newly emerged"? Speaking of Nigeria, and I think this applies to Ghana, too, there is local anxiety, and indeed determination, to demonstrate to the world that United Kingdom standards and, therefore, international recognition, can be achieved for professional qualifications gained locally. Even if nationalistic politicians are prepared to sacrifice standards to this end, I am convinced the people will not be willing to accept a parochial lower standard. They are particularly sensitive to any suggestion that they cannot make the same grade in the same time as a European student. Although academically we were satisfied that better results would be obtained by an engineering degree course of four years from university entrance owing to lack of "mechanical background," it was considered desirable from the national prestige angle to make the course the same length as in the United Kingdom (even though the wastage rate might well be high), because the good man had the same chance as his opposite number in the United Kingdom to complete in the minimum time.

Syllabuses may well be modified to give a more general training required for the "general practitioner" and also special slants such, for example, as "irrigation engineering" or "refrigeration and air conditioning"—but not standards.

If the people of a newly emerged country wish to establish and retain recognition at international standards, then they must clearly accept that any university or professional body providing the umbrella for such recognition, until the country can stand on its own feet, must satisfy itself as to conduct of examinations and standards. This necessity is, I believe, fully understood by those directly concerned, but perhaps the most difficult problem to solve will be to reconcile the diplomatic but firm insistence of the United Kingdom bodies to control standards with strong nationalistic tendencies from the political angle.

I am, Sir, yours faithfully,

C. A. HART,
Rector and Principal (on leave).
Nigerian College of Technology.

County End, Bushey Heath, Herts.
26 February, 1960.

Concrete Strengths

SIR, With reference to the discussion in your recent issues between Mr. T. N. W. Akroyd and Dr. J. M. Plowman on concrete strengths in relation to temperature, two factors seem to have been left out of account, namely, the effects of tricalcium aluminate and aggregate-lime reactions.

Tricalcium aluminate governs the early growth of strength and if this is related to later strength by any "law," such law must be purely coincidental. As shown by my own work (see "Principles Underlying the Steam Curing of Concrete at Atmospheric Pressure," *Magazine of Concrete Research*, Vol. 2, No. 6, Mar. '51, p. 127), that of W. H. Price ("Factors Influencing Concrete Strength," *Journal of the American Concrete Institute*, Vol. 22, No. 6, Feb. '51, p. 417) and others, a higher early temperature results in a higher early strength but a lower later strength.

Fortuitously, as shown by my results not as yet published, the growth of strength curves, related to various rates of early temperature rise to boiling point, all tend to intersect at a maturity equivalent to that provided by a slow temperature rise to boiling point in six hours. Six hours' steam curing, hot water or oven treatments, therefore, all result in very similar strengths regardless of strict control. A treatment of about this duration is, therefore, very suitable for predicting later normal cured strength. Later steam-cured strengths are, of course, considerably affected by early control.

Continuing for up to a fortnight at boiling point after a slow temperature rise, using natural sand and gravel aggregates, I obtained strengths over 20 per cent higher than those anticipated

for the maturity. This tendency for higher strengths was also noted for continued treatments at temperatures as low as 50° C, and I am at a loss to know why Dr. Plowman's results are different. Similar treatments with neat cement and less siliceous aggregates gave results reasonably in conformity with the maturity. I thus feel justified in attributing this discrepancy to silica-lime reaction and, since the majority of aggregates are siliceous, strength at higher temperatures may normally depend on aggregate characteristics rather than any other factor.

Such reactions, no doubt, also take place during normal steam curing treatments, but, in this case, the temperatures are not elevated for a sufficient time to affect the strength-maturity relationship to a ponderable extent.

Yours faithfully,

A. G. A. SAUL.

Cement and Concrete Association,
52 Grosvenor Gardens,
London, SW1.
5 March, 1960.

Principles of Transport

SIR, The letter of Brig.-General Sir H. Osborne Mance (ENGNG., 4 Mar. '60, p. 312) appropriately centred round his phrase "equal competitive conditions" for road and rail; all the measures he advocated were clearly aimed, in his estimation, at bringing about that state of affairs.

There is no novelty in that aim. In 1932, the Salter Conference, comprising four top railwaymen (Walker, Stamp, Wedgwood, Milne) and four comparable road transport men (Gosselin, Turner, Gaunt, Guest) met under the chairmanship of Sir Arthur Salter (now Lord Salter) for the very same purpose of "establishing what would be a fair basis of competition and division of function between rail and road in the transport of goods . . . and to consider the factors relating to the incidence of highway costs in relation to the contributions of the different classes of mechanically propelled vehicles."

After long deliberation of the principles underlying this intricate matter—which are abiding principles, as valid today as they were in 1932—the conference produced its unanimous report, upon which an interesting sidelight was recently thrown by Mr. J. E. Allen who wrote, "When I asked Lord Stamp how the representatives of the road interests were induced to sign the report, he said: 'It was a miracle!'" (*Sunday Times*, 6 Sept. '59).

It is thus to be noted that the four leading railway barons of that era were elated at the outcome of the conference. They were men who ran railways profitably. To decry the bargain they drove is to repudiate them. And to ignore the Salter Conference altogether, as Sir Reginald Wilson has done in his 43 page paper to the British Association at York, is—curious. However, the younger generation may be curious to know what the report stated.

It said, "We consider that the total contribution payable by all classes of mechanically propelled vehicles, whether in the form of licence duty or petrol duty, should be equal to the current expenditure on the roads"; and it laid down an increased scale of taxation under which 39 per cent of the revenue would come from commercial goods vehicles, 61 per cent from passenger vehicles.

As a result of the Salter Conference report, motor taxation rose, viciously, from £43 million in 1931 to £62 million in 1933. Ever since, the government of the day has departed from the letter of the report, and been introxicated by its spirit, so that there has come to be imposed upon motor transport more than four times the penalty that delighted Lord Stamp.

Thus highway expenditure, under every conceivable heading, amounted in the financial year 1958-59 to appreciably less than one-quarter of the £564 million raised in motor taxation. Furthermore, in that same year, as in the year before, the Government advanced—a euphemism—a sum of no less than £208 million for the benefit of British Railways. We have the spectacle of the Chancellor of the Exchequer seeking to redress some mystic balance between road and rail by himself bearing down heavily on one pan of the scales while he compells the taxpayer to jack up the other one.

What does Sir Osborne Mance really mean by "equal competitive conditions"? Nothing new, I suggest. He can be studied further on this subject in the July, 1959, *Journal of the Institute of Transport*. There he did mention the Salter Conference, showing that he had some respect for it, though not very much: he would revise the incidence of taxation so that a typical 16-tonner at present paying £471 annually would pay £1,070! On top of that, it has to be remembered that a lorry's share of the £500 million or more wasted annually in delays due to the highway congestion that has come upon us since 1932 is probably more than £1,000 already, and is increasing fast.

I suggest that by "equal competitive conditions" Sir Osborne Mance only means that on some pretext or other—such as that of "track costs," which was fully explored by the Salter Conference—the process of pricing road movement up and up, artificially, must continue until its convenience is almost completely submerged in expensiveness.

How out of tune that would be, Sir, with your dictum, "Britain, a compact country, deserves good communications"; for the essence of a good communications system is convenience. May I suggest that the height of convenience will be achieved when our motor vehicles are free to travel not only on our highways, but also on the additional five-figure mileage of Clearways readily obtainable by turning *our* railways into roads. There lies the "objective track development to secure the cheapest transport for the community" that Sir Osborne Mance professes to champion, as is becoming more and more widely recognised throughout the country, though the very extensive literature establishing the case for this form of development continues to be ignored officially.

Yours faithfully,

T. I. LLOYD.

24 Grove Road,
Merrow, Guildford,
Surrey.
6 March, 1960.

Thermodynamic Theory

Sir, Since you have granted my book *Foundations of Thermodynamics with Antitheses and Disputation* a gratifyingly spacious review (ENGNG., 20 Nov. '59, p. 514), I trust that you will kindly give me an opportunity to comment. At the same time, I wish to express my sincere appreciation of the reviewer, Mr. William Drummond, who, despite the fact that he appears taken in by a theory largely incompatible with mine, strikes the correct and scientifically wholesome attitude of commending my work for earnest consideration.

Mr. Drummond refers to "the classics" in a way to suggest that current thermodynamic dogma is essentially different from the classical one after Carnot and Clausius. This is not so, Mr. Carathéodory's tentative paper notwithstanding. While Mr. Drummond agrees with me "that some of the early work contained suspect arguments," I, for my part, must object to be identified with his following statement "and also many mathematically intolerable concepts such as reversibility and ideal engines."

Mr. Drummond's comment that "It is most surprising that the work of Carathéodory (about 1920) is not mentioned, though some of the mathematical treatment is vaguely similar," also requires some comments. Carathéodory's work does not seem to be very generally known or referred to in major *thermodynamic* works—with one exception shortly to be commented upon. That my treatment may be vaguely similar to that of Carathéodory, should not be surprising: we are both concerned with solving the classical problem of establishing the general integrating denominator to the imperfect differential of heat, dq.

Finally, I hardly agree with Mr. Drummond's statement that "the application of thermodynamic theory to chemical dynamics . . . is of lesser importance." This is a field where a fundamental thermodynamic theory may be put to an acid test and, if true, may be most useful; for example, in unambiguously identifying Svante Arrhenius's "energy of activation" and also with "what hitherto has loosely been termed *relative affinity*" (see articles in the *Encyclopedia Britannica*, 14th edition, by H. M. Dawson on "Chemical Action," and by Harold Baily Dixon on "Chemistry").

Carathéodory's original paper, "Untersuchungen über die Grundlagen der Thermodynamik," is to be found in *Mathematische Annalen* for 1909, p. 355. It is a link in a very curious sequence of attempts to prove the generality of Clausius's "$dq = T\,ds$": on considerations essentially pertaining to the perfect gas laws Planck first endeavours to demonstrate this generality; Carathéodory, by very abstract and indefinite mathematical methods, tries to improve on this and thereby achieve the generality at which he declares he aims; Planck, in turn, rejects his original demonstration and Carathéodory's basic argumentation, but ends up with a mathematical proof nearly identical with that of Carathéodory. This last of Planck's demonstrations I have carefully considered and repudiated in the book you have reviewed, a critique that substantially applies to Carathéodory's demonstration as well. Surely, this sequence of superimposed attempts to provide a valid proof for the generality of Clausius's equation amply testifies to my claim that it is not soundly grounded as well as to the correctness of my new theory.

Carathéodory's work is marked by the odd ambition expressed in his proposition: "*One can deduce the whole theory [of heat] without premissing the existence of* one from the ordinary mechanical quantities deviating physical quantity, the *heat*. To make this clear in all details is the purpose of the present work" (the italics and parenthesis are mine). Notably, Carathéodory has only one definite physical premise, namely the Law of Conservation of Energy.

In addition, he mentions the "basic axiom for the Second Law" quoted by Mr. Drummond, which is a mere tautology on the definition of an adiabatic process, perfectly useless for the evolution of any physical facts; we may replace the word "adiabatic" in this axiom by either of the predicates isothermal, isobar, isochor and have three new but equivalent axioms, physically equally insignificant. For the rest, Carathéodory presents no definite physical premises; that is, no experimental result whatever to make clear the functional relationships involved—for example, for a pure substance or an one-component system: the limiting case of the perfect gas or the special domain of equilibrium between two or more phases of one and the same substance.

To anticipate anything but physically meaningless results from such premises, however brilliant the mathematical exposition, may be a harmless expression of super-faith in the metaphysical; a faith which will ordinarily be automatically disillusioned. But when the mathematical exposition with preavowed purpose is bent to produce desired results, it is time to protest. In fact, it is not difficult, in Carathéodory's work, to discern where this bending goes over into definite crookedness.

An exposure of Carathéodory's error in this respect will be published separately, as it is beyond the scope of a letter to the Editor. When available in print, I trust, Sir, that you will kindly inform your readers about the details of this publication.

Yours faithfully,

SVEN SVANTESSON.

Österskär,
Sweden.
3 March, 1960.

Plant Engineers in Conference

Papers to be submitted at this year's annual conference of the Institution of Plant Engineers will cover an even wider field than usual and, in addition, there will be group discussions on "Developments in Materials of Construction," "The Training and Education of Supervisory Staff," and "The Engineer's Function in Industrial Safety."

Following the presidential address by Mr. E. C. Stevens, M.A., B.Sc.Tech., papers will be presented by Dr. Richard Weck, M.I.C.E., Director of Research to the British Welding Research Association, on "Developments and Problems in Welding," and by Mr. F. S. Walker, chairman of Lever Brothers, Port Sunlight, Limited, on "People—The Most Important Factor in Industry."

An encouraging response has been made in past years to the Council's invitations to non-members of the Institution to take part in the conference proceedings. A number of industrial undertakings are accordingly being asked to nominate members of their senior staffs to attend the 1960 conference.

This three-day event, which will include a special conference dinner on the Thursday, will be held at the Grand Hotel, Scarborough, from 4 to 6 May. The Institution's headquarters are at 2 Grosvenor Gardens, London, SW1 (Telephone SLOane 0469).

Exhibitions and Conferences

Cologne Household Goods and Hardware Fair.—Fri., 11 Mar., to Mon., 14 Mar., at the Fair Grounds, Cologne. Agent: Mr. Neven du Mont, 18 Queensberry Place, South Kensington, London, SW7. Tel. KENsington 6593.

Inventors' Exhibition, Ninth International.—Fri., 11 Mar., to Sun., 20 Mar., at Brussels. Apply to the Institute of Patentees and Inventors, 207 Abbey House, Victoria Street, London, SW1. Tel. ABBey 1616.

Lyons International Trade Fair.—Sat., 12 Mar., to Mon., 21 Mar., at Lyons. Agents: Robert Brandon and Partners, Ltd., 47 Albemarle Street, London, W1. Tel. HYDe Park 0901.

Vienna International Spring Trade Fair.—Sun., 13 Mar., to Sun., 20 Mar., at Vienna. Apply to the British-Austrian Chamber of Commerce, 29 Dorset Square, London NW1. Tel. PADdington 7646.

Stationery and Allied Trades Fair, Sixth National.—Mon., 28 Mar., to Fri., 1 April, at the Royal Horticultural Society's Old and New Halls, Vincent Square and Greycoat Street, London, SW1. Organised by the *National Newsagent, Bookseller, Stationer*, 149 Fleet Street, London, EC4. Tel. CITy 2604.

Nuclear Congress: Comprising the **Sixth Nuclear Engineering and Science Conference,** the **Eighth Atomic Energy in Industry Conference** and the **Sixth International Atomic Exposition.**—Mon., 4 April, to Thurs., 7 April, at the Coliseum Exhibition Building, New York. Congress offices: 33 West 39th Street, New York, USA.

Plastic Crystals and Rotation in the Solid State, Symposium.—Tues., and Wed., 5 and 6 April, at the Inorganic Chemistry Laboratory, Oxford. Sponsored by the Office of Ordnance Research, United States Army. Details obtainable from Mr. L. A. K. Staveley, Inorganic Chemistry Laboratory, South Parks Road, Oxford.

Mineral Processing Congress, International.—Wed., 6 April, to Sat., 9 April, at the Church House, Westminster, London, SW1. Organised by the Institution of Mining and Metallurgy, 44 Portland Place, W1. Tel. LANgham 3802.

X-Ray Analysis Group of the Institute of Physics, Spring Conference.—Fri., and Sat., 8 and 9 April, at the main chemistry lecture theatre, The University, Reading. Theme: "The Borders of X-Ray Analysis." Information obtainable from Dr. P. T. Davies, "Shell" Research Ltd., Thornton Research Centre, P.O. Box 1, Chester.

Ship Trials and Service Performance Analysis, Symposium.—Mon., 11 April, to Wed., 13 April, in Newcastle upon Tyne. Organised, in cooperation with the Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2 (Tel. Central 5181), by the North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle upon Tyne 1. Tel. Newcastle 20289.

Basic Questions in the Structure of Languages, Symposium.—Thurs., 14 April, to Sat., 16 April, at the Hotel New Yorker, New York. Sponsored jointly by the American Mathematical Society and the Association for Symbolic Logic. Apply to the secretary, American Mathematical Society, 190 Hope Street, Providence 6, Rhode Island, USA.

Stability Problems in Hydrodynamics, Symposium.—Thurs., 14 April, to Sat., 16 April, at the Hotel New Yorker, New York. Sponsored by the American Mathematical Society, 190 Hope Street, Providence 6, Rhode Island, USA.

Manned Space Stations, Symposium on.—Wed., 20 April to Sun., 24 April, at the Ambassador Hotel, Los Angeles, Calif., USA. Organised by the Institute of Aeronautical Sciences, 2 East 64th Street, New York 21.

Compressed Air and Hydraulics Exhibition, International.—Mon., 25 April, to Fri., 29 April, at Olympia, London, W14. Organised by *Fluid Power, Incorporating Compressed Air and Hydraulics*, St. Richard's House, Eversholt Street, London, NW1. Tel. EUSton 7293.

Meetings and Papers

Antiquarian Horological Society

LONDON
"The Work of the Ellicotts." Discussion. Science Museum, Exhibition Road, SW7. Fri., 18 Mar., 7 p.m.

Association of Supervising Electrical Engineers

LONDON
"Role of the Engineer and of the Architect in the Planning of Electrical Installations." Discussion. 26 Portland Place, W1. Tues., 15 Mar., 6.30 p.m.*

British Institution of Radio Engineers

LONDON
"Short Range Navigational Aids." Discussion. Radar Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Mon., 14 Mar., 6.30 p.m.*

CARDIFF
"Recent Developments in Printed and Potted Circuits," by H. G. Manfield. South Wales Section. Welsh College of Advanced Technology, Cardiff. Wed., 16 Mar., 6.30 p.m.

Chemical Society

SWANSEA
"Optical Rotatory Dispersion in Structural Organic Chemistry," by Dr. W. Klyne. Swansea Branch. Department of Chemistry, University College, Swansea. Mon., 14 Mar., 5.15 p.m.

Combustion Engineering Association

BIRMINGHAM
"Research Towards Improving Mechanisation and Automatic Control in Industrial Coal-Fired Boilerhouses." Discussion, opened by G. G. Thurlow. Midland Region. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Thurs., 17 Mar., 10.15 a.m.

Diesel Engineers and Users Association

LONDON
"Factors Governing Turbocharger Design," by C. L. G. Worn. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 17 Mar., 2.30 p.m.

Illuminating Engineering Society

SHEFFIELD
"Television Studio Lighting," by R. W. Koplick. Sheffield Centre. Grand Hotel, Sheffield. Mon., 14 Mar., 6.30 p.m.

Institute of Fuel

SHEFFIELD
"Fuel Technology and the Future," by Professor M. W. Thring. Yorkshire Section. Royal Victoria Hotel, Sheffield. Wed., 16 Mar., 2.30 p.m.

Institute of Physics

LONDON
"Friction and Deformation of Solids at Very High Speed," by Professor F. P. Bowden. London and Home Counties Branch. Thurs., 17 Mar., 6 p.m.

NEWCASTLE UPON TYNE
"Applications of Thermoelectricity," by Professor D. A. Wright. North Eastern Branch. King's College, Newcastle upon Tyne. Tues., 15 Mar., 6.15 p.m.

Institute of Road Transport Engineers

LONDON
"Transport in Tripolitania," by H. L. Lyons-Jones. Royal Society of Arts, John Adam Street, Adelphi, WC2. Thurs., 17 Mar., 6.30 p.m.

LEEDS
"Unusual Types of Trailer Suspension, Including Air Suspension," by J. L. B. Crane. Yorkshire Centre. Great Northern Hotel, Wellington Street, Leeds 1. Thurs., 17 Mar., 7.30 p.m.

Institute of Welding

LONDON
"Improved Steels and Their Weldability," by J. F. Wilkinson. North London Branch. Wed., 16 Mar., 7.30 p.m.*

Institution of Civil Engineers

LONDON
"Impact of Motorways on Cities," by F. Gibberd and R. Nicholas. Joint meeting with the Royal Institute of British Architects. 66 Portland Place, W1. Tues., 15 Mar., 6 p.m.*

Institution of Electrical Engineers

LONDON
"Should Engineers be Encouraged to Take up Administrative Positions Early in Their Careers?" Discussion. Joint meeting with the London Graduate and Student Section. Mon., 14 Mar., 6 p.m.*
"Fast-Response Transistor Chopper-Type Amplifier with Low Carrier Frequency," by I. C. Hutcheon and D. Summers. Measurement and Control Section. Tues., 15 Mar., 5.30 p.m.*
"An Electrostatic Dust Monitor," by Dr. D. H. Grindell. Supply Section. Wed., 16 Mar., 5.30 p.m.*

BIRMINGHAM
"Teaching of Magnetic Amplifier Theory." Discussion opened by K. C. Parton. South Midland Centre. College of Technology, Gosta Green, Birmingham. Tues., 15 Mar., 6 p.m.*

Institution of Engineering Designers

NEWCASTLE UPON TYNE
"The Churchill Linkline," by J. A. Mills. North East Branch. Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne 1. Mon., 14 Mar., 7.15 p.m.

Institution of Heating and Ventilating Engineers

LEEDS
Film Display and Annual General Meeting. Yorkshire Branch. Griffin Hotel, Leeds. Wed., 16 Mar., 7.30 p.m.

Institution of Highway Engineers

DURHAM
"Mining Subsidence with Special Reference to Highways," by R. J. Orchard. Annual General Meeting. North East Branch. University Science Laboratories, Durham. Fri., 18 Mar., 7 p.m.

Institution of Locomotive Engineers

LONDON
"Class 25 Condensing Locomotives on the South African Railways: Design and Operating Experiences," by Prof. Dr. Ing. R. Roosen. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Tues., 15 Mar., 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
"Automobile Braking," by Dr. R. C. Parker. Crompton-Lanchester Lecture. Automobile Division. Wed., 16 Mar., 6 p.m.*

BLACKBURN
"Manufacture of Watches," by A. W. Marshall. North Western Branch. Offices of the North Western Electricity Board, Jubilee Street, Blackburn. Wed., 16 Mar., 7.30 p.m.

Institution of Plant Engineers

ROCHESTER
"Power from Nuclear Energy," by Dr. M. D. Wood. Kent Branch. King's Head Hotel, High Street, Rochester. Wed., 16 Mar., 7 p.m.

Institution of Production Engineers

LONDON
"Modern Techniques in Plastic Moulding," by J. L. Riley. Annual General Meeting. Royal Commonwealth Society, Northumberland Avenue, WC2. Thurs., 17 Mar., 7 p.m.

Institution of Structural Engineers

GLASGOW
"Piling in Structural Engineering," by W. G. N. Geddes. Scottish Branch. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Tues., 15 Mar., 7 p.m.

Royal Aeronautical Society

LONDON
"Supersonic Aircraft: Promise and Problems," by M. B. Morgan. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, Westminster, SW1. Thurs., 17 Mar., 6 p.m.*

Royal Institution

LONDON
"Infra-Red Radiation," by Professor R. V. Jones. Fri., 18 Mar., 9 p.m.

Royal United Service Institution

LONDON
"Rockets, Satellites and Military Thinking," by Sir Frederick Brundrett. Wed., 16 Mar., 3 p.m.

Society of Instrument Technology

LONDON
"Simulation of a Large Chemical Plant on an Electronic Analogue Computer," by A. H. Doveton and K. C. W. Pedder. Control Section. 26 Portland Place, W1. Wed., 16 Mar., 7 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

Antiquarian Horological Society. Apply to Mr. E. J. Tyler, 95 Barnfield Avenue, Kingston-on-Thames, Surrey.
Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London WC1. (LANgham 5927)
British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Diesel Engineers and Users Association, 18 London Street, London, EC3. (ROYal 2393)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1. (LANgham 7124)
Institute of Physics, 47 Belgrave Square, London, SW1. (BELgravia 6111)
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248)
Institute of Welding, 54 Princes Gate, Exhibition Road, London, SW7. (KNIghtsbridge 8556)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Highway Engineers, 47 Victoria Street, London, SW1. (ABBey 3891)
Institution of Locomotive Engineers, 28 Victoria Street, London, SW1. (ABBey 6672)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Institution, 21 Albemarle Street, London, W1. (HYDe Park 0669)
Royal United Service Institution, Whitehall, London, SW1. (WHItehall 5854)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)

Distribution of Stress in Anchor Blocks

Experiment shows that, in the anchorage zone of post tensioned concrete members, the dangerous tensile stresses are disposed differently from and are larger than theoretical analysis had indicated.

By R. E. Rowe and J. Zielinski
Cement and Concrete Association

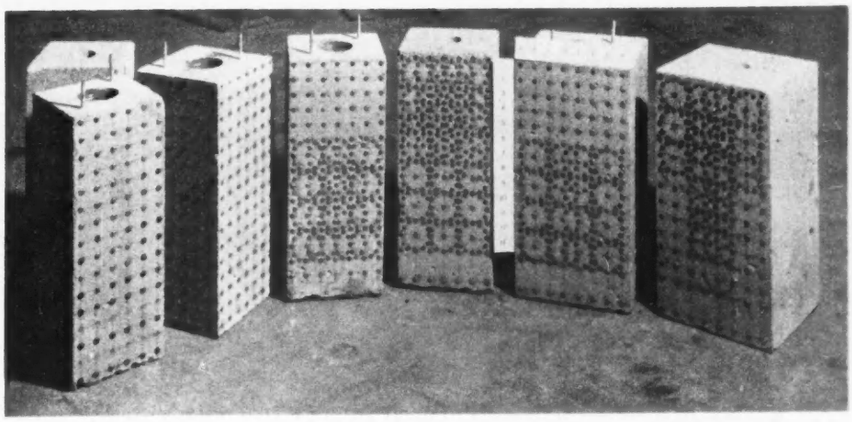


Fig. 1 A selection of the square-section end blocks used in anchorage stress tests. Stresses were measured in terms of the relative movements between pop marks in reference discs fixed to the concrete.

Since the advent of prestressed concrete, quite a number of theoretical approaches to the problem of the stress distribution in the end of members subjected to large concentrated forces have been put forward. Relatively little experimental work has been carried out, however, and hence some doubt as to the accuracy of the various theories exists. This is evidenced by the fact that most Codes of Practice give no guidance on this subject.

In view of the uncertainty that exists, an extensive series of tests has been undertaken by the Structures Department of the Cement and Concrete Association. The experimental work has been divided into two stages; in the first stage, a detailed study of the stress distribution on the surfaces of simple square-section prisms subjected to various single concentrated loads; in the second stage a detailed study of the surface stress distribution in various cross-sections, subjected to a number of concentrated loads, is being carried out. The second stage is supplemented by tests to determine the internal stresses in end blocks of various shapes.

The first stage of the investigation has been completed and this note is primarily concerned with the scope of the investigation and the results obtained. The major variables considered in the tests were:—

(*a*) The ratio of the loaded area to the cross-sectional area of the prism.

(*b*) The type of anchorage—either embedded or external.

(*c*) The percentage and form of the reinforcement.

The above variables were considered in relation to the post-tensioning systems used in this country at the time the investigations commenced. Hence the embedded anchorages considered were either Freyssinet female cones or PSC cast-steel anchorages for four and eight 0·276 in diameter wires. (It is proposed to carry out similar tests using CCL spiral anchorages at a later date.)

The test specimens, some of which are shown in Fig. 1, were of three types, with different areas of cross-section and different lengths to cover the range of values of the ratios of loaded area to cross-sectional area of 0·31 to 0·72; this range covers those values which occur frequently.

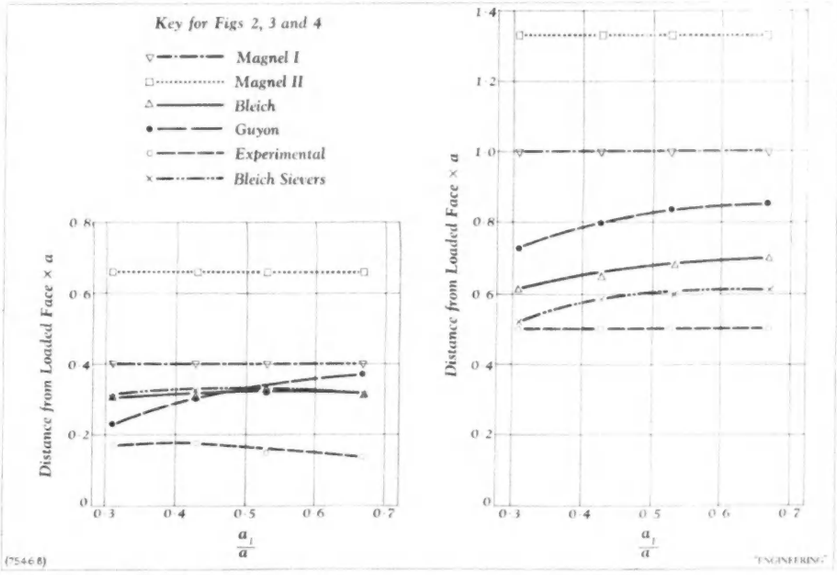


Fig. 2a Distance of zero transverse tensile stress. *Fig. 2b Location of maximum tensile stress.*

Fig. 2 Distance of the zero tensile stress zone (Fig. 2a) and the maximum tensile stress (Fig. 2b) from the face of the end block, according to various theories and as found experimentally.

Figs. 2*a* and *b* show a comparison between the theoretical and experimental positions of zero and maximum transverse tensile stress plotted against the ratio $\frac{a_1}{a}$ where $2a_1$ is the width of the square loading area and $2a$ is the width of the square end block. The difference between the theoretical and experimental values is considerable but, of greater importance, the positions found experimentally are virtually independent of the ratio $\frac{a_1}{a}$. The data from which the figure was derived consisted of surface strain measurements; subsequent tests to cracking and failure confirmed these results.

The maximum experimental tensile stresses, f_y, which always occurred on the centre lines of the surfaces of the end block, are shown as a function of $\frac{a_1}{a}$ in Fig. 3; in the figure the maximum tensile stress is expressed as a ratio of the uniform compressive stress, f_c, obtained by dividing the total applied load by the cross-sectional area of the end block. The experimental stresses are considerably greater than those predicted by the various existing theories, typical values being

$$0{\cdot}73f_c \quad \text{for} \quad \frac{a_1}{a} = 0{\cdot}30$$

and

$$0{\cdot}40f_c \quad \text{for} \quad \frac{a_1}{a} = 0{\cdot}70.$$

These stresses are, respectively, 2·0 and 2·8 times those predicted by Guyon's theory and 1·6 and 2·0 times those predicted by Magnel's theory.

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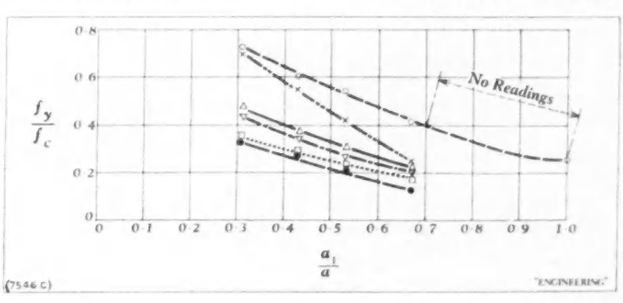

Fig. 3 (right) Maximum tensile stresses expressed as a ratio of the mean compressive stress for different block proportions.

Movable Flood Barrier in the Thames

The construction of a movable flood barrier across the River Thames to give protection to the heavily built areas of London against tidal-cum-surge flooding is a "technically feasible" proposition, according to a report published as a Blue Book.

The report is the work of a technical panel, consisting of officers of government departments and local authorities, that was established on the recommendation of the Waverley Committee which had been appointed in April, 1953, to consider the implications of the East Coast floods of earlier that year. The panel had the assistance of two firms of consulting engineers in formulating the details of the barrier. The consultants were Rendel, Palmer and Tritton, and Sir Bruce White, Wolfe Barry and Partners, both of London.

The proposals of the consultants cover three forms of barrier which might be established at a site known as Long Reach, between Erith and Tilbury. Long Reach is straight and about 3½ miles long, so any barrier sited in the mid-length of the Reach would be in the view of shipping approaching from either side for a considerable period. The chalk bedrock would provide a sound foundation for the barrier. It would protect London from tides 6 ft higher than those experienced in 1953.

In coming to their recommendations the consultants considered six types of barrier. They rejected three of these types and devoted their attention to the remaining three. Those rejected were the submerged type (which had the especial virtue that it offered no obstruction to shipping in normal times), the bascule and hinged types. The three forms considered in greater detail were based on a vertical lift bridge, a swing bridge and a side launching retractable structure. Estimates of cost of such a structure at 1958 prices range between £13 and £17½ million. On final consideration the consultants preferred the two bridge types to the retractable, but could not choose between the two bridge forms without further investigation.

For comparison, consideration was also given to the possibilities of raising the flood defences throughout the upper reaches of the river by 2 ft or 3 ft; the cost was £9·3 and £11·5 million respectively. The barrier has the additional advantage that it could be arranged to carry a highway crossing of the river for an extra cost of £6 million.

The report, which contains sketches of the suggested barriers, is entitled *Technical Possibilities of a Thames Flood Barrier*, and is published by the Stationery Office, price 3*s* 6*d*.

Concluding Stress in Anchor Blocks

The principal conclusions drawn from the series of tests are—

(*a*) The transverse stress distribution and the ultimate load of an end block are not significantly affected by the anchorage being either embedded or external, nor by the method of anchoring the wires.

(*b*) The dominant factor in the transverse stress distribution and the ultimate load is the ratio of the loaded area to the cross-sectional area of the prism, i.e. in these tests on the ratio $\frac{a_1}{a}$. There is no significant difference between the stress distribution caused by circular or square loading areas, provided that the ratio specified above is the same for each type of loaded area.

(*c*) At a distance of 2*a* from the loaded face (2*a* being the width of the square prism) some transverse tensile stresses still exist, though their magnitude is negligible from the point of view of practical design.

(*d*) The percentage of reinforcement has a significant effect on the bearing capacity of end blocks when the value of the contact stresses, i.e. the compressive stresses immediately under the loaded area, are smaller than about 1·9 times the cube strength of the concrete. Generally speaking, the contact stresses are limited to some fraction of the cube strength and hence they do not enter into the design considerations.

(*e*) At the cracking load, the uniform compression, f_c, was 0·14 and 0·28 of the corrected compressive strength, i.e. the prism strength, for values of $\frac{a_1}{a}$ of 0·30 and 0·70 respectively.

Based upon the results of these tests, it is possible to formulate a procedure suitable for design office use. This procedure, which is given in detail in the full report of the tests*, enables both the amount of reinforcement necessary and its distribution to be determined for individual end blocks. Obviously the effect of a number of concentrated loads is that normally required in practice and this problem is being covered in the second stage of the investigation. However, in the existing theories, the treatment of numerous concentrated loads is that of finding a series of equivalent prisms each loaded with only one concentrated force. This appears to be a rational procedure and hence, as an interim measure, it may be applied to the experimental results so far obtained.

* Rowe R. E. and Zielinski, J., "An Investigntion of the Stress Distribution in the Anchorage Zone of Post Tensioned Concrete Members." Cement and Concrete Association (to be published).

Modernising a Building in Use

Continuous use of a building while part of it is gutted to permit modernisation is a fairly common occurrence, but it is a quite exceptional problem for owner and builder alike when the building is a high quality hotel that is kept open to an international clientele. Yet in the Strand Palace Hotel in London—one of Europe's three largest hotels—111 bedrooms with their own bathrooms have been remodelled in 96 days. The contractors were Holland & Hannen and Cubitts Limited of Queen Anne's Gate, London, SW1.

The work was carried through without interruption to the normal activities of the hotel, which has over 900 bedrooms. The contractors say that the rapidity of the work, and the relatively low cost of £80,000, was made possible by detailed planning by the hotel, the architects (F. J. Wilson and Son) and themselves right from inception of the scheme, together with a large element of prefabrication. To keep a close control over the progress of the work key personnel carried pocket radios. The average time taken to strip each room, instal the new plumbing and electrical circuits, and redecorate each unit was 5½ hours.

275 kV Crossing of the Severn

The film of the construction of the supergrid line over the River Severn has had its first showing. Seven 275 kV cables now span the one mile estuary between towers that are 500 ft high and there are two side spans that are ¾ mile long, the one on the north side crossing the River Wye. The line forms part of the main electrical transmission line between South Wales and South-West England, and the crossing is one of the most difficult river crossing ever made with transmission lines.

The main contractors were J. L. Eve Construction Company Limited of London who, besides designing the towers, had also to devise new methods for erecting the lines before work could commence. The conductors are aluminium wires (gross area 0·782 sq. in) over a core of steel wires (0·913 sq. in) and are continuous over 2¼ miles. The weight of each cable as slung was 23 tons.

In the film it was shown how the conductors were hauled across the river while they were supported at intervals of 120 ft from a steel pilot cable stretched between the two anchor towers and over the tops of the two main towers. Suspenders with free-running sheaves at each end were used to carry the conductors which were pulled into position using a steel rope. Special arrangements were required to enable the hauling rope to be disengaged while the conductors were threaded through the insulators on the main towers and coupled at the anchor towers.

J. L. Eve Construction are also to build the 275 kV line between Beauly and Kintore for the North of Scotland Hydro-electric Board. They have placed an order for the lattice steel towers with William Bain and Company Limited, Lochrin Iron Works, Coatbridge. The weight of steel involved is about 4,000 tons.

Precast Concrete on Film

"Precast Concrete" is the title of a new film that has been made by Concrete Limited, the makers of Bison units. Made in Eastman Colour, and running for 27 minutes, the film well illustrates the contribution that precast concrete makes to modern structural engineering practice.

The film opens with a shot of precast H frame construction and compares typical examples of *in situ* and precast work, especially for the building of multi-storey flats, where precast walls are used in conjunction with beams, columns and floor slabs. Some cadid shots show the difficulties of marrying up precast members, and record the need for make-up *in situ* concrete, but the film also shows how this can be properly catered for with prepared shutterwork. Other shots give a good indication of the size of member that can be factory produced and transported to the site.

Sequences taken at the Bison works at Hounslow, Middlesex, show the production lines at work; a typical manufacturing cycle is based on a 24 hour curing period between placing the concrete and striking the shutters. Research into both strength problems and manufacturing methods has always been an important part of the Company's activities. One sequence shows some hollow prestressed beams being grouted and cross-stressed in a one-third scale bridge mock-up. The film concludes with shots of completed buildings.

Copies of the film, which is educational in content rather than an advertisment, can be borrowed without charge from the distributors, Sound Services Limited, 269 Kingston Road, London, SW10.

Car Parking and Traffic Problems

The British Road Federation is holding an exhibition of car parking at the Institution of Civil Engineers, in London, from 18 to 26 March. It is described as the most comprehensive collection ever of models, photographs, and drawings of buildings designed to house the parked car in all possible situations. Examples have been obtained from all over the world.

Schemes and completed projects from all five continents are to be represented, showing multi-storey, mechanical and ramp type garages, for both above and below ground. A detailed catalogue, giving location and operating data for each garage, will be available. Other motorway service areas, motels, and commercial centres arranged with motor drive-in will also be displayed.

A visit to the United States from 24 April to 7 May to study traffic problems is being organised by the Pavings Development Group. The visits will cover the road tests that are being carried out by the American Association of State Highway Officials (AASHO). Installations to relieve traffic congestion in New York and Chicago will be inspected. Arrangements are being made for delegates to have ample discussions with the authorities concerned.

Full details can be had from the secretary of the Group at Terminal House, Grosvenor Gardens, London, SW1. The expected inclusive cost of the visit is about £480.

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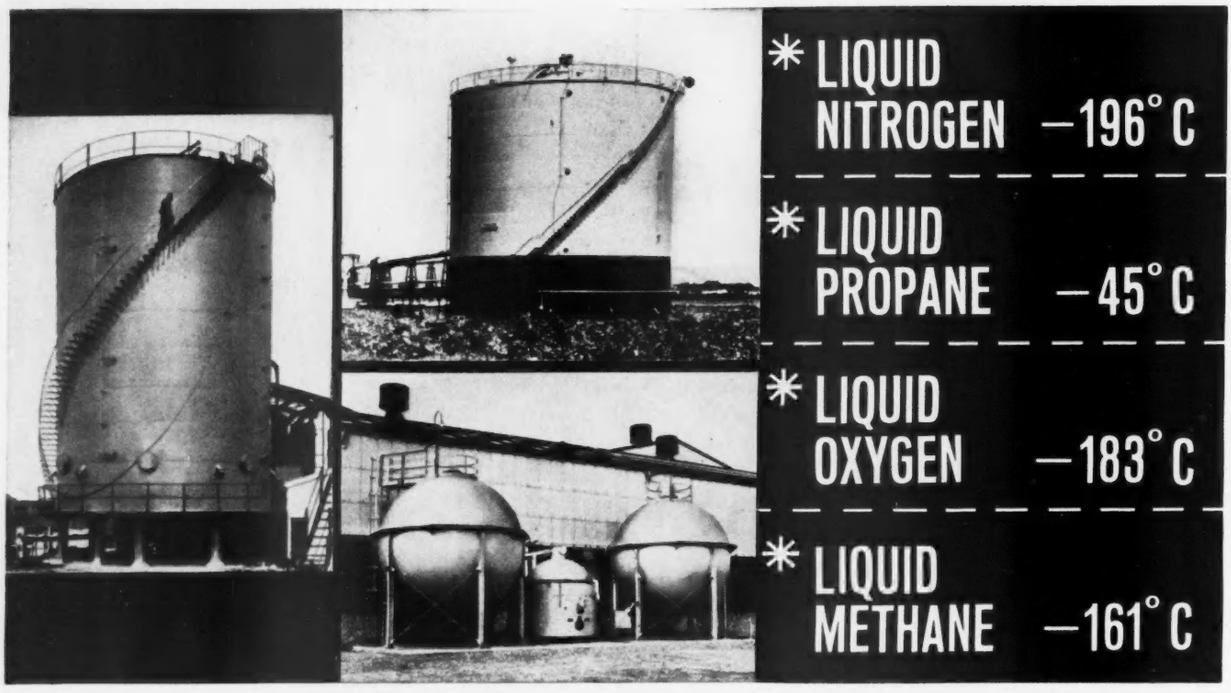

The first 1,000 ton liquid methane tank to be used in this country, insulated and double skinned storage spheres and tanks for liquid oxygen and liquid nitrogen, are examples of the experience and skill of Whessoe in designing and building large tanks or vessels for the bulk storage of liquid gases at extremely low temperatures.

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Human Element

Explain and Persuade

The essential art of communication in management is that of carrying the team with you.

Pointing to this more honoured than observed truism, Lord Baillieu, president of the British Institute of Management, opened the 12th International Congress of Scientific Management, at Sydney, Australia, with a lecture entitled "The Next Ten Years in Management."

With the Government lending money to the steel industry and the motor firms and about to put its funds into aircraft, Lord Baillieu considerably understated the case when, describing the host of considerations which now affect the modern manager, he referred to "ever increasing governmental codes, regulations and limitations."

The BIM president may or may not be right to describe the powers of the trade unions as "growing" but he no doubt came close to the special problem of the present day executive when he pictured him as being much in the hands of suppliers, subcontractors and distributors. Over the next decade and beyond the manager will continue to face this problem of conducting his business, sometimes with the help of and sometimes despite, all these outside factors.

Since mass communications have become almost instantaneous the influence of public opinion makes itself more and more apparent.

Lord Baillieu cut through a lot of the nonsense that is built up round modern business machines, computers and high speed calculators generally. The executive must essentially acquire a clear understanding of the uses and significance of these techniques. But the computer is there to handle arithmetic, not to do the planning.

In Lord Baillieu's view, planning for the broad conduct of company policy, of small as well as large companies, must take increasing account of political, economic and social change at home and abroad.

Succession

Lord Baillieu examined in detail the problem of where the future top management is to come from. Sub-division of activities and greater specialistation has brought about a situation where the lower managerial positions are too limited in their function to be the training ground for the broad and varied experience proper to leadership.

Since the responsibilities of management are not likely to whither away in the future, the training schemes and courses for senior management, exemplified in the higher staff colleges, are certain to be of greater and greater importance.

It is not so easy to imagine why Lord Baillieu preaches that management—"in cooperation with labour, must seek to preserve the pride of craftsmanship, the sense of independence, and of dedication in the operation of industry." He gives no reasons for "dedication" and with the steady approach to the 40 hour week, the decline in purely piece-rate working and the elimination of individual decisions by operatives the thought has perhaps a better sound than sense. What a little "independence" can do on a shop floor is well reflected in the annual figures of man-hours lost by strikes.

Guaranteeing the Guarantees

Serious misuse of the words guarantee and guaranteed is alleged by the Retail Trading Standards Association in its report to the Committee on Consumer Protection.

Despite the fact that many people must by now have experienced the lack of real meaning in these terms when applied by some retailers—one example is the bill for labour running into pounds when a valve worth a few shillings is replaced in a "guaranteed" radio set—they were still found by the association to carry weight with the public. This despite the well-known public dislike of reading the terms of an agreement, though often enough the guarantee would not be in writing.

A clear sign of the difficulty of making progress by agreement arose with the association's recommendation that a Government appointed body should have power to issue "cease and desist" orders so that an advertisement which was not approved could not be carried in any media until suitably amended. The two directors of advertising agencies on the association's council of management did not agree.

The independent Government appointed body proposed by the association would have powers similar to those wielded by the American Federal Trade Commission. Other recommendations were for more informative labelling on certain consumer goods, a proper definition for guarantees and some control over advertising.

Investing in Blind Workers

There are at least two good reasons for employing blind workers. One is that they have a lower accident average than sighted people. The other is that they have a strong tendency to stay in the job; they have not caught the current tendency to hop about from job to job.

Any further reasons, such as giving the handicapped a hand are additional and more a matter for the employer's self-regard.

Already there are more than 10,000 employed blind people in the United Kingdom but there are several hundred waiting for jobs. If greater employer-interest were created larger numbers could be trained. What is being done to inform their potential employers about the blind? The great problem that stands in the way of the Ministry of Labour's special placing officers is lack of knowledge among executives of the simple fact that the blind are well able to give a full week's work in return for a wage packet.

Quite apart from the blind switchboard telephonists and the physiotherapists there are efficient blind shorthand typists; and there are lathes, drilling, grinding and milling machines that can be used by the sightless. A wide range of inspection work with specially adapted gauges and micrometers is suitable for the blind. Some adaptation is without cost the to the employer.

A campaign has now been launched throughout the country, by the Ministry of Labour, under the slogan "Blind Workers are Good Workers—let them do a good job for you."

The Ministry's pamphlet for distribution in the campaign does not waste words. It says "to employ a blind worker in a suitable post is not an act of charity but a sound business investment."

Equal Opportunity for Electricians

To an electrician it matters which wire is red and which is green. To the electricians of Local 26 of the United States' International Brotherhood of Electrical Workers it is the colour black that matters. No Negro has ever been admitted to membership.

Mr. George Meany, president of the American Federation of Labour-Congress of Industrial Organisations, is fighting the Local and has offered to recruit non-union Negro electricians to work on a government contract in Washington D.C.

Local 26 controls all electrical work on government contracts in the capital, an area with a high proportion of coloured people. Mr. Meany is a member of the President's committee on government contracts but he has had no support in his one-man fight against union race-discrimination from vice-President Nixon, who leads the committee, or any other members.

It is not foreign to the history of union leaders to struggle for equality of opportunity. It is a doubly tough task when it has to be done against union members.

Engineering the Future

Are engineers a definable group with a clear influence on the mental as well as material state of man?

Mr. Georges Ville, délégue général de la Société des Ingenieurs Civils de France, evidently thinks so. A recent issue of the *Professional Engineer*, the magazine of the Engineers' Guild, carried a report of Mr. Ville's argument presented to a joint meeting of the British section of the Société and the Metropolitan Branch of the Guild.

The engineer's function in changing the amenities and conditions of the individual is plain enough and his impact on social conditions, through communications, transport and so on is all around.

Mr. Ville moves on into less charted ground when he describes all this as producing a new ethic in which preference for the paternal state and the smallest effort lead steeply down to the couldn't-care-less attitude and to "a morality of empty desire."

That the engineer has no more, and no less, authority to influence the use of what he creates is no new thought, but Mr. Ville suggests that while the scientists have unleashed power which they no longer command, the engineer has in his work the opportunity to correct the artificial divorce between technology and social conditions.

It is possible, says Mr. Ville, to introduce social considerations right to the heart of production and technical problems. A simple example is the ability of the engineer to make the working life of mechanics simpler, easier, even safer, though when Mr. Ville includes "more remunerative" he goes beyond conditions relating employment to pay in most of industry.

The allegation that the philosopher and the speculative moralist no longer carry weight in modern society rests on the arguable assumption that they ever prevailed against considerations of gain and expediency, for which evidence would take a little finding. More certainly Mr. Ville sees that "the politics of production" require modification if the essential human values are to be maintained and that it is here that the engineer is involved in the humanist world of sociology.

Turbine Executive leads Engineering Employers

Mr. Vincent Everard, who is works director of the Birmingham engine and turbine makers Belliss and Morcom, has become president of the Engineering Employers' Federation.

His appointment is in succession to Sir Kenneth Hague who this year concluded with the engineering unions the agreement on a 42 hour week.

The machinery is expected to be set moving towards a new pay claim when the Amalgamated Engineering Union national committee meets next month, so Mr. Everard is the man who presumably will have to tell the union leaders that a general wage increase would not be in the interest of the engineering industries.

The precise position of the engineering firms towards the end of the year cannot be accurately stated but, prosperous though it is expected to be, the atmosphere is likely to be set by the Chancellor of the Exchequer's appeals to bring the prices down and by the continued sharpening of competition.

A substantial part of Belliss and Morcom's position stands upon their export performance, which makes Mr. Everard at least as aware of the ever present threat of foreign producers as was Sir Kenneth Hague.

Swift Agreement on Cotton Wages

The 7½ per cent wage increase for cotton workers negotiated so swiftly by a special joint committee of the unions and the employers last month has now been accepted at a full meeting of the executives of the unions concerned.

Two hundred thousand men and women receive the increase and it is thought that the cost to the industry will be about £5,500,000 in a full year.

It is a sign of the returned prosperity of the cotton firms that the negotiations were conducted with a speed unusual where so much money is at stake. A month after first receiving the unions' application the employers' and unions' representatives met and those of the employers stated that they conceded the principle of an increase but they were not able to make an offer.

Eight of their members, with eight union men, who had originally asked for 10 per cent more, then started work as a joint negotiating committee. The agreement, described by Sir Alfred Roberts, general secretary of the National Association of Card, Blowing and Ring Room Operatives, as "very fair" was reached by mid-afternoon.

The New Liners for 1960

This year is to see the launching or maiden voyage of eight or nine big passenger ships. The next to be launched is the Canberra. The Chandos report on the replacement of the Queens is due this month.

Last June, the Cunard Steamship Company submitted their proposals to the Government for the "Queen" replacements. These proposals raised such complex issues that the Government decided to take expert advice in the matter and a small committee was consequently set up under the chairmanship of Lord Chandos, of Associated Electrical Industries Limited. Naturally, it will be some considerable time before their findings can be implemented, but from the eight or nine passenger vessels due for completion in various parts of the shipping world this year, it is possible to get a good general idea of present trends in shipbuilding design.

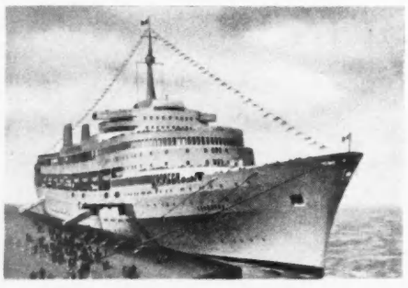
As far as engines are concerned, the steam turbine still rules the roost and the diesel engine has not caught on for the large liner. A ship like the Canberra needs about 85,000 h.p. and, since the biggest diesel is only around 20,000 h.p., about five such units would be required; and this would be even worse with a ship of 80,000 tons. The twin-screw vessel driven by steam turbines is, therefore, the most suitable propulsion system for these passenger liners. Even when nuclear propulsion comes into its own, this unit will only, in effect, replace the boilers.

There is a tendency to put the engines aft, since this gives a better layout, with the passengers in the centre of the ship. The oil fuel can be located anywhere that is most convenient and pumped to the engines, whereas with coal-fired boilers the coal bunkers had to be amidships, to that there was not too much change in trim as the coal was used up. Engines are smaller for the same power than they were, but recent changes have only been refinements that have not reduced the size appreciably.

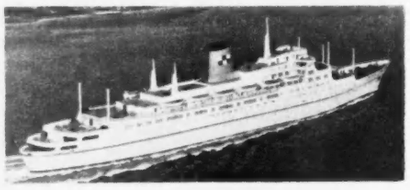
Welded instead of riveted construction is now the thing, the main advantage being that it enables parts to be prefabricated. This means that they can be built up under cover, at some distance from the ship's berth, the size of component being dictated only by the size of crane available. Welds are stronger than riveted joints and the cost of construction is less. Aluminium is being used for the superstructure in many cases and in the Canberra, for instance, the saving in weight by doing this is 1,500 tons, which means that an additional deck accommodating about 300 passengers is possible. Another point to note is that certain equipment, such as stabilisers, radar and air-conditioning, are standard equipment these days.

Of the passenger ships in this and other countries, listed alphabetically in the table, some have yet to be launched, some have been launched and others have made (or are about to make) their maiden voyage.

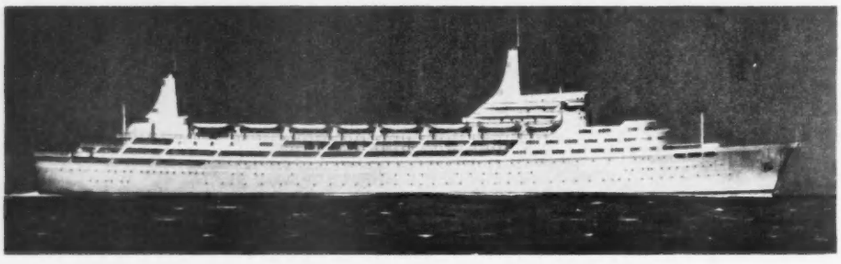
Named and launched on 7 July last by Her Royal Highness the Princess Margaret, the 20,000 ton Amazon was designed for the South



Canberra

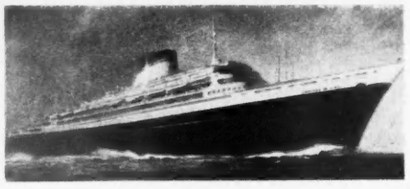


Empress of Canada

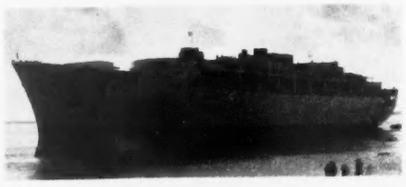


Sister ship of the Southern Cross

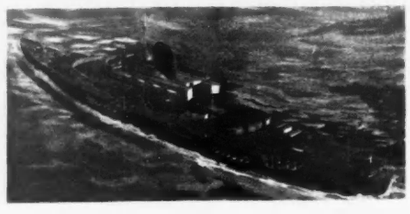
France



Leonardo da Vinci



Oriana



Windsor Castle

TABLE.—*Passenger Vessels to be Launched or making Maiden Voyages in 1960*

Vessel	Owner and capacity	Built at	Service and Notes	Launch	Maiden voyage
Amazon	Royal Mail lines 20,000 tons 464 passengers	Belfast Harland & Wolff	South American mail run	7 July '59	January '60
Aragon	Royal Mail Lines 20,000 tons 464 passengers	Belfast Harland & Wolff	—	October '59	—
Arlanza	Royal Mail Lines Passengers and cargo	Belfast Harland & Wolff	—	On the slipway in January '60 under construction	—
Canberra	P and O 45,000 tons 2,250 passengers and cargo	Belfast Harland and Wolff	Australia and the Pacific. The biggest British liner since the *Queen Elizabeth*	16 March '60	—
Empress of Canada	Canadian Pacific 27,500 tons 1,060 passengers	Tyneside Vickers-Armstrongs	For transatlantic service to Canada and for cruising	May '60	—
France	French Line 56,000 tons 2,000 passengers	St. Nazaire Chantiers de l'Atlantique	Prestige ship for Atlantic. Subsidised	May '60	Spring '62
Leonardo da Vinci	Italia Line 32,500 tons 1,300 passengers	Genoa Ansaldo	For transatlantic service. Replacement for *Andrea Doria* Subsidised	—	June '60 Genoa to New York
Oriana	Orient Line 40,000 tons 2,100 passengers	Barrow Vickers-Armstrongs	Sister of *Canberra*	November '59	December '60
Transvaal Castle	Union Castle 35,000 tons 750 passengers	Clydeside John Brown	South Africa mail run	December '60	—
Windsor Castle	Union Castle 38,000 tons 850 passengers	Birkenhead Cammell Laird	Biggest ship for the South Africa run	23 June '59	18 August '60
	Shaw Savil Line 22,000 tons 1,400 passengers	Tyneside Vickers-Armstrongs	Passenger liner, sister ship to the *Southern Cross* Round the world to Australasia		1962

American service of Royal Mail Lines by Harland and Wolff Limited of Belfast. She can carry 464 passengers and 4,200 tons of cargo, and set off on her maiden voyage in January of this year. A sister ship, the Aragon, was launched in October last and a third ship, the Arlanza, is still on the slipway at Belfast.

The 45,000 ton P and O liner Canberra, the largest British liner to be constructed since the Queen Elizabeth, will carry 2,185 passengers to Australia and the Pacific. Built by Harland and Wolff in Belfast, she is to be launched this month. (An article on the Canberra appears in the Design section of this issue.)

The Canadian Pacific's Empress of Canada, is to be launched on 10 May at Newcastle upon Tyne by Mrs. John Diefenbaker, wife of the Prime Minister of Canada. This liner, at 27,500 tons, is the flagship of the Canadian Pacific's fleet. She was designed by Vickers-Armstrongs Limited, and will be the largest liner to sail into Montreal when she goes into service in 1961 and joins her sister ships, the Empress of England, built in the same berth as the new liner, and the Empress of Britain. The Empress of Canada is streamlined, fully air conditioned and equipped with stabilisers, radar and other navigational aids. She will carry 1,060 passengers, 200 of them first class, at a cruising speed of 20 knots.

The 56,000 ton French Line vessel, the France, is now under construction at St. Nazaire, where it is being built by the Chantiers de l'Atlantique (Penhoët-Loire) for the Compagnie Generale Transatlantique. This prestige ship will carry 2,000 passengers (500 first class) and is to be launched this May with a maiden voyage planned for the spring of 1962.

The France will be fitted with stabilisers which, it is claimed, will prevent the ship from rolling more than 2 degrees either way, and without having any effect on the ship's speed. In accordance with present-day methods, welding is being used instead of riveting for the hull, with the idea of cutting down weight, and prefabricated sections have been used a great deal. The service speed is to be 31 knots, so she will be able to make the Le Havre-Southampton-New York crossing in five days. The ship is to be fully air conditioned and will be fitted with a closed-circuit television system.

A replacement for the ill-fated Andrea Doria is now under construction in Genoa for the Italia Line. This is the 32,500 ton Leonardo da Vinci, which was launched last year and is due to make her maiden voyage from Genoa to New York in June. Her turbine propelling machinery will give the ship a speed of about 24 knots. She has accommodation for 1,300 passengers.

The Orient liner Oriana, of 40,000 tons, was launched at the Barrow-in-Furness shipyard of Vickers-Armstrongs last November and is scheduled to make her maiden voyage in Decembe of this year. She will carry 2,100 passengers, of whom 600 will be first class, at a service speed of about 27 knots. Extensive use is being made, as in the Canberra, of aluminium in the superstructure. About 90 per cent of the structure is prefabricated and welding has been carried out, by hand and automatic machines, using the argon-gas-shielded metal-arc process. Another feature of the Oriana is the bulbous bow, used so often in ships these days, with the idea of cutting down the resistance of the vessel and the amount of water shipped over the bows in rough weather. This ship is propelled by twin screws, each driven through double-reduction gearing by a set of steam turbines of Pametrada design. The total maximum designed s.h.p. is 80,000 at 157·5 r.p.m. propeller. The ship is also fitted with transverse propulsion to reduce the hazards of docking and to assist in manoeuvring in confined waters. This system is operated by remote control from the bridge.

The Windsor Castle, the new 38,000 ton 850 passenger Union Castle liner, was launched from the shipyard of Cammell Laird and Company (Shipbuilders and Engineers) Limited, at Birkenhead last June. She is due to make her maiden voyage in August and will be the largest passenger vessel ever employed on the Union Castle mail service to South Africa, as well as being the largest passenger vessel ever built on Merseyside. Her main engines will develop 45,000 h.p. in normal service to give her a cruising speed of 23 knots. She will thus do the 6,000 mile trip from Southampton to Cape Town in just over 11 days. The main engines consist of high-pressure steam turbines driving twin screws.

Very little information is yet available on the other Union Castle Line ship, the Transvaal Castle, except that she is to be a 35,000 tonner carrying 750 passengers on the South Africa mail run. She is due for launching in December.

An order by the Shaw Savill Line for a 22,000 ton passenger liner, a sister ship to the Southern Cross, now in full operation and making four voyages a year, has been secured by Vickers-Armstrongs Limited of Tyneside. The ship is to enter service in 1962. The design will follow the same general lines as the Southern Cross, with engines and funnel aft. She will carry no cargo and all her 1,400 passengers will be in one class. Steam turbines of 22,000 h.p. will give her a speed of 21 knots.

New Look in the German Shipyards

For the past two years the German shipbuilding industry has been breaking records with annual deliveries of about 1·2 million tons gross register. Now their activity is not quite so high, and Britain has moved in above Germany in second place among the world's shipbuilders. Does this mean that the Germans are facing a sharp decline? Orders still in hand total some 3 million tons, which is some 800,000 tons less than a year ago. Clearly, with the continued slump in world shipping, with some owners trying to put off delivery dates and others cancelling contracts, the industry is going to have a difficult year.

What sort of new orders have been coming in, and how are they being dealt with? The biggest order is for two 85,000 tons tankers for Erling Naess of New York placed with the government-owned Howaldt shipyard at Hamburg. These are for delivery in 1963-64. These tankers, the biggest ever built in Germany, will cost around £4 million each. Howaldt's other yard, at Kiel, has an order for three 4,000 to 6,000 ton ferry boats for Norway worth a total of £3 million. Other new orders include two 20,000 ton tankers for Egypt, and two 11,600 ton cargo vessels for the Hamburg-Amerika Line to be built by Deutsche Werft at Hamburg.

Negotiations are going on for long-term credit guarantees to be granted to the shipbuilders by the state-run Hermes Export Credit Insurance Institute of Hamburg in connection with possible orders from India, Israel and the Soviet Union. Several shipyards are involved in the talks including Howaldt, and Blohm and Voss. One of the big problems facing the shipbuilding industry is the sharp drop in the proportion of home orders in the last two years. While the volume of ships built for foreign orders went up by 160,000 tons during this period, domestic orders, largely as a result of shortage of capital, fell by 290,000 tons. This fall in home orders has particularly affected the small and medium shipyards which have not the capital to bid for foreign contracts. To help get over this difficulty, eight small Schlesweg-Holstein yards have formed an export association, and five others in the North Sea and Baltic have set up the Nord Deutsche Schiffbau GMBH at Lübeck.

While the small builders are in fairly serious trouble, the big yards are not in immediate difficulties. One result of the slump is a proposal to rationalise the ship yards to take advantage of new production techniques. At present four yards in Germany, Howaldt at Kiel, Schlieker and Deutsche Werft at Hamburg, and the Krupp-owned AG Weser at Bremen are capable of building ships of 100,000 tons.

The most modern yard in Hamburg, and probably in West Germany, is also the youngest. This is the Schlieker yard which launched its first ship in 1954. Herr Willy Schlieker its owner, is a steel merchant with go-ahead ideas. One of these is the use of standard size plates measuring 10,000 by 2,400 mm. Since 1958, the Schlieker yard has had the largest graving dock on the Continent. This is 1,070 ft long and 184 ft wide and can take ships of 100,000 tons and is served by a 100 ton crane. It was originally built by the German navy and escaped dismantling after the war only because its destruction would have involved the adjacent traffic tunnel under the Elbe.

Several shipyards are making preliminary studies on the use of electronic computers. These could take care of the production programmes of an entire shift and control the movements of cranes, roller conveyers and other machines. To be a practical proposition, however, computer control will need a series of ships built to a few standard designs. The saving in costs involved would, it is claimed, make standardisation worthwhile.

So far as size is concerned the trend in orders received by German shipyards has been upwards except for tankers. Here, and for dry cargo carriers, it is believed that vessels of from 36,000 to 45,000 tons will be standard for some time to come with the big tankers, such as the two 65,000 tonners built for Aristotle Onasis by Howaldt at Kiel, as the exceptions.

The smaller shipyards meantime are concentrating on special types of vessel. The Seebeck Werft at Bremerhaven, which is associated with the Krupp AG Weser Yard has, developed a 10,500 ton cargo liner with the engine aft. The same yard has built fishing trawlers, buoy-laying ships, ferries and ice-breakers to special designs. One example is the General San Martin, the world's first fully welded icebreaker, which has the distinction of having penetrated farther south than any other vessel. Another notable product of a small shipyard is the powerful 768 ton tug Atlantic built by F. Schichau at Bremerhaven. This has two Deutz diesel engines with a total of 5,000 h.p., a top speed without tow of 17 knots and an operating radius of 13,000 nautical miles. The Atlantic is owned by Bugsier-Reederei und Bergungs AG of Hamburg.

The Orenstein-Koppel and Leubecken Maschinenbau of Lübeck has specialised in the construction of floating cranes, dredgers and similar vessels. Four big diesel-electric suction dredgers, each with a stowage capacity of 40,000 cu. yd, have been built since 1956. These have gone to India, the Soviet Union and Indonesia (2). Floating cranes of 100 tons have been made for use in Norway and Iraq.

The 16,000 ton tanker Esso Bolivar was recently bought by the Hamburg Gesellschaft führ Energieverwertung and sent to the Howaldt yard at Kiel to be fitted with an experimental nuclear power plant. The work is estimated to take from 2 to 3 years and will cost from £1½ million to £2½ million. Four German shipyards are engaged in research projects using nuclear energy for marine propulsion.

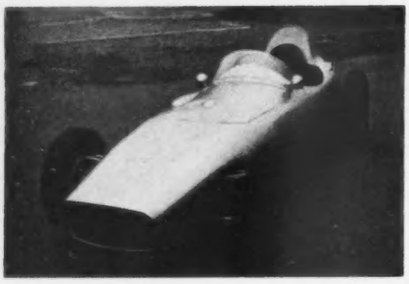
One type of vessel for which the Germans have received no orders whatsoever since the war is the big passenger liner. The reasons are that German shipping lines are on the whole short of capital and that no one is prepared to build a new Bremen or Europa until it becomes clear how the fleets of other nations stand up to competition from the big jet airlines.

All told, however, German shipyards, although less busy than a year or two ago, present a picture of varied activity and of optimism.

Two British Formula Juniors

By Gordon Wilkins

The Condor designed by Mike Thorburn and built by the Condor Motor Car Company of Guildford is the first British Junior with a Triumph Herald engine. General arrangement is conventional with engine in front of the driver in a space frame, the main members of which are 1 in steel tubes (17 s.w.g.) reinforced by ¾ in tubes. Rigidity is increased by the floor panels welded to the chassis. Suspension is all-independent by coil springs and Armstrong telescopic dampers. Steering is by rack and pinion, and Girling brakes with two leading shoes at front and rear have aluminium drums with steel inserts and radial fins.



The Condor Formula Junior

The front suspension uses double tubular wishbones, providing adjustment for camber and castor. At the rear the transmission shafts are used as suspension members. Extending forward from each is a radius arm and the magnesium hub carrier extends downwards to provide pivot points for two transverse radius arms. With the driver in the car rear wheels have a distinct inward camber.

A 7¼ in Borg and Beck clutch is used with a Triumph Herald gearbox equipped with special ratios 2·93, 1·69, 1·24 and 1 to 1. To lower the seat level a transfer box is introduced before a BMC-Condor differential. Several final drive ratios are available and the rear brakes are mounted inboard close to the differential.

A variety of engines can be fitted but the standard power unit is a modified Triumph Herald engine with larger bore, balanced crankshaft and pistons, special camshaft, larger valves, lightened valve gear, two SU carburettors of 1¼ in and compression of 10 to 1. The ex-works price, with modified Triumph engine, is £1,250.

The bolt-on magnesium alloy wheels have front drums of 4·50-15 and rear 5·00-15. Two types of body are planned with quick release panels, one with open cockpit as illustrated, the other enclosing the driver to his shoulder.

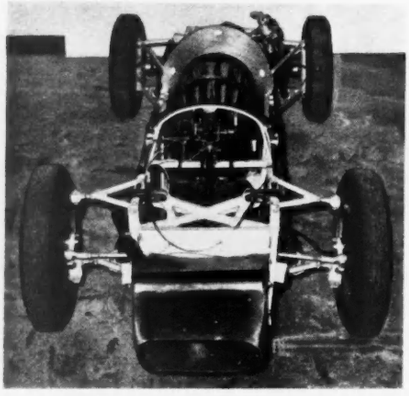
Dimensions.—Wheelbase 7 ft 6 in. Track front and rear 4 ft. Length 12 ft. Ground clearance 4½ in. Height 3 ft 6 in. Weight, including oil and water, 814 lb.

The Envoy car, which is the smallest and lowest-priced British Formula Junior single seater model produced so far, has the BMC "A" type engine behind the driver in a chassis, with a 90 in wheelbase and weighs about 800 lb with oil and water.

Designed by Ian Raby, the well-known driver, and Ken Cooper, it has a lattice girder frame made of 1 in square steel tube with reinforcements of ⅜ in tube. Like Eric Broadley, the Lola designer, the builders of the Envoy have adopted the principles of chassis tuning so that the handling characteristics can be varied to suit the circuit and the performance of the driver. Steering ball joints and the mountings of the unequal wishbones at the front can be adjusted to alter castor and camber and on the prototype three different positions for the upper mountings of the Girling coil spring and damper struts allow the front spring rate to be altered. At the rear there are also sprung struts with adjustable top mountings, in conjunction with pairs of wide based wishbones. The transverse arms of each wishbone pivot on ball joints which can be mounted in various holes on the chassis cross-members to vary rear wheel camber and roll centre. There is a choice of location for the ball joints on the long forward projecting arms on the prototype. Steering is by rack and pinion and there is an anti-roll bar.

Enough adjustment points will be retained in production to give expert drivers and mechanics the chance of securing optimum road holding to suit different types of circuit. Besides this, the Envoy designers have concentrated on obtaining minimum frontal area and low power losses. The engine lies behind the driver in the very narrow chassis frame and to keep the fuel tank within the slim outline, the three gallon tank has been mounted under the driver's knees. For long distance events another tank can be fitted under the scuttle.

The power unit on the prototype is a BMC "A" four-cylinder engine but other plants can also be fitted. It drives through a Borg and Beck 7¼ in diameter clutch to a pair of drop gears in a light alloy housing and so into a Fiat 600 gearbox and final drive unit. Fiat drive shafts are also used with extra universal joints at the outer ends and Fiat hubs are carried in light alloy housings. The engine can be supplied unmodified or with Barwell modifications which raise the output to 74 b.h.p. at 6,500 r.p.m. Special gears giving 4 or 5 speeds can be supplied to fit the Fiat casing. Cooling is by ducted radiator in the nose of the car connected to a crescent shaped header tank on the bulkhead behind the driver. The battery is just behind the radiator and fuel feed is by an SU electric pump. Fully assembled with stock BMC engine and Fiat gears, the Envoy costs £900 ($2,520) at works. A kit of parts without engine costs £775 ($2,170). Manufacturers are Sewel and King, Chelmsford, Essex.



Chassis tuning of the Envoy Junior car is done by altering the position of steering ball pivots, wishbone mountings and damper anchorage to change the camber, castor and roll centre.

Improved Hillman Husky at Geneva

The Rootes Group presented at the Geneva Motor Show an improved Hillman Husky, lower, more comfortable, with better vision, and a new gearbox. In front the 1960 model is distinguished by a new grille, chromium cowls over the headlamps, thinner screen pillars and windscreen which is both deeper and wider. The roof panel is now projecting slightly over the windscreen and the rear door to increase the impression of length and the rear part is ribbed to increase rigidity and reduce body noise over bad roads. Interior lining of the roof is in washable plastic. The rear window is also larger. Seats are lower and wider and front seat back rests have foam rubber overlays. A new frame construction is claimed to prevent front seats accidentially tipping forward.

The engine is the same 4-cylinder 1,390 c.c. unit improved in detail. It gives 51 b.h.p. at 4,400 r.p.m. on an 8 to 1 compression ratio. Gearbox is now the same as that of the 1960 Hillman Minx, controlled by a short centre lever.

Radio, heater, thermometer and clock are optional extras. With an overall length of only 12 ft 5½ in, the Husky is easy to park but it has space for four persons and 300 lb of luggage. With back seat folded, makers claim 600 lb of cargo can be carried, or 750 lb with driver only on board. It is the most popular British station wagon on the USA market.

Triumph Herald Convertible

After the sedan and coupé, a Triumph Herald convertible made its debut at the Geneva Show, showing how easy it is to multiply types of bodywork with this method of construction (by separate panels on a robust and rigid chassis). The folding top can be erected in 30 seconds without the passengers leaving the car. There are only two toggle action fastenings above the windscreen. The top can be opened and packed away in its box behind the rear seats in a little over 60 seconds. There it is concealed by a cover attached by press studs which follow the smooth line of the open car.

The sporting line of the open convertible matches the road qualities given by the all independent suspension and the twin-carburettor 948 c.c. Herald engine which gives 50·5 b.h.p. at 6,000 r.p.m. The top is in vynide plastic with transparent windows on the corners and in the rear giving good all-round vision. The trunk has a volume of 30 cu. ft. As an extra, a tonneau cover is provided.

The Herald convertible has the same design features as the other models; adjustable steering column which telescopes in case of accident, hood combines with the wings tilting on forward pivots to give free access to engine, accessories, steering, brakes and front suspension, adjustable body panels for easy repair and a chassis which needs no greasing.

POWER SUPPLY

Variable Output

A VARIABLE direct current output is obtainable with the type PV25OB power supply unit.

The unit is intended for such applications as experimental electronic circuits, bridge energising, and the like. The direct current output is variable from zero to 250V at 50mA and there is in addition a fixed alternating current output of 6·3V at 1·5A for heater supplies. A switched meter provides three voltage ranges 0 to 10, 0 to 50, and 0 to 300V, permitting the output voltage to be set and read accurately at all levels, and also a current range of 0 to 50mA. Remaining ripple is 80mV at 50mA on the 250V range or 25mV on the 10 and 50V ranges.

For general laboratory use the output can be taken from four insulated jack top terminals on standard $\frac{3}{4}$ in spacing mounted on the front. For more permanent connection the multipoint socket on the right-hand side of the instrument may be used.

Voltage adjustment is by a special

series valve circuit providing high setting accuracy at low output levels. Using an external voltmeter, the level can be adjusted as accurately at 0·1V as at 50V. The current can be adjusted smoothly to any value between 0 and 50mA even into a short circuit. The d.c. impedance is low on the 250V range and high on the other two so that the instrument tends to be a constant voltage source at vacuum tube levels and a constant current source at transistor levels. The case measures $9\frac{7}{8}$ in wide by 6 in deep by $5\frac{3}{8}$ in high. It weighs $9\frac{1}{2}$ lb. *Claude Lyons Limited, Valley Works, Ware Road, Hoddesdon, Hertfordshire.*

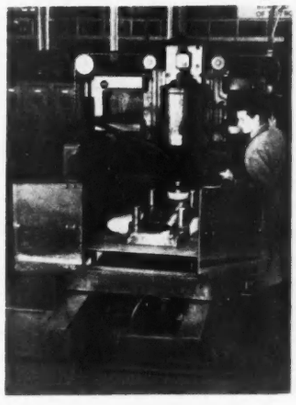
PRECISION GRINDER

Facing Dies

THE Lumsden 230X is a plane grinder primarily for the precision grinding of the joint faces of die sets.

The machine is of the vertical spindle type. The rotary table is mounted on a carriage which is reciprocated under the wheel by means of a hydraulic cylinder giving infinitely variable speeds from 5 to 30 ft per minute. It is claimed that the reversal is completely free from shock so that fine finishes can be obtained. Fine hand movement to the wheel head, vertically or transversely, allows grinding to be carried close to shoulders, die pins or locating dowels.

The carriage supporting the table and its driving motor slides on protected V-ways. The table rotates on an oil bath track. There are two table sizes, 30 in or 48 in diameter, and two speeds, 8 or 16 r.p.m. The motorised head has a 12 in hand down feed and the thrust is taken up by spring loading and counter balancing. Provision is made on the columns for adjusting the alignment of the wheel with the rotary table. The



machine's saddle can be cross traversed.

Housed in the machine base—a heavy box casting—are the hydraulic pump and motor, the reverse and control valves and the oil tank. Robust columns support the cross rail which carries the saddle and the vertical grinding head. *Alfred Herbert Limited, Coventry.*

ENCLOSED MOTOR

Class E Insulation

A NEW range of totally enclosed fan cooled motors is being introduced which comply with the BS Draft Specification A (ELE) 1629.

They are dimensionally interchangeable with ventilated motors to BS 2960 and are smaller in size and weight than earlier totally enclosed types. These machines comply with BS 2613 for Class E insulation and give a similar horsepower output.

The foot mounted range has been developed up to $7\frac{1}{2}$ h.p. at 1,500 r.p.m and will be extended up to 40 h.p.; flanged and other versions are to be produced. With the exception of the smallest frame size the stator housing is ribbed on the outside. This increases the cooling surface area and imparts strength to the shell design. Machines of this type are suitable for use in a dirty or fluffy atmosphere.

A range of similar motors will be introduced soon, built to NEMA/CEMA dimensions and frame sizes. *Higgs Motors Limited, Witton, Birmingham 6.*

HAND EMBOSSER

For Vinyl Tape

THE Midgie is a small hand tool for embossing vinyl tape for labels.

The tape, which has a pressure-sensitive backing, is housed in a magazine at the handle end of the tool, which will hold 12 ft of tape $\frac{1}{2}$ in wide. Letters and numbers are set by the two dials while the tool is held in the right hand. The tape is self-feeding, moving forward after each pressure of the operating trigger ready for the next letter. The lettering is permanently embossed to $\frac{5}{32}$ in type size.

At the delivery end of the machine is a cut-off lever to separate the completed label from the strip. The tape is hard wearing and resistant to chemicals and corrosion generally. It will adhere to most smooth, clean surfaces. Being weatherproof it can be used in the garden and outdoors, as well as under cover. The tool itself measures only $10\frac{1}{2}$ in long, so it can easily be carried about by the operator. *British Automatic Company Limited, 14 Appold Street, London, EC2.*

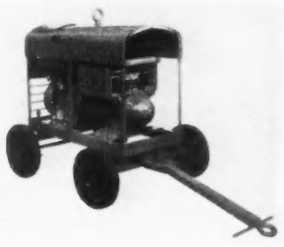
MOBILE WELDER

Petrol-Engine Driven

THE Arcmaker is a mobile welding equipment in which the power is supplied by a petrol engine.

The output is from 30 to 200 A at 30V and the generator is a variable voltage type with laminated pole pieces. Voltage and current can be varied independantly, and are self indicating, thus simplifying the setting of the welder. Wing nut terminals permit easy changing of polarity. Either bare or shielded electrodes can be used.

The petrol engine is a JAP twin cylinder unit of 824 c.c. capacity with bore of 80 mm and stroke of 82 mm. The maximum rating is 15 b.h.p. and the continuous industrial rating 12·8 b.h.p. The cylinders are made of close grained cast iron with circumferential fins for cooling. Cylinder heads are aluminium alloy. The pistons are aluminium alloy and the connecting rods and crankshaft steel. The cooling fan is aluminium. A vacuum operated device is fitted to keep down petrol consumption when the engine is idling.



The drive to the generator is through a flexible coupling with Silentbloc bushes. The whole unit is mounted on a steel frame with a pressed steel canopy for weather protection. The SA 150 model illustrated is mounted on four small diameter running wheels with a steering front axle. Alternatively it can be supplied with two large diameter wheels and a jockey wheel for fast road towing. In that case the unit is steadied with screw jacks when in operation. The lifting eye on the top is placed to enable the whole to be raised in balance by a single hook. *Lincoln Electric Company Limited, Welwyn Garden City, Hertfordshire.*

BIFURCATED FANS

For Corrosive Fumes

THE latest additions to the range of Turbro-Cyclone bifurcated fans are designed to handle corrosive fumes up to temperatures of 50° C.

The six blades of the fans are true aerofoil section and are made of rigid pvc. Sizes range up to 30 in diameter. It is particularly claimed for these fans that they are suitable where space is limited as they can be mounted either vertically or horizontally direct in the duct systems. The bifurcated arrangement isolates the motor entirely from the fumes, so that it is not liable to deterioration and yet leaves it available for easy access for routine maintenance and servicing.

The fan casings are made, like the blades, from rigid pvc with pvc angle flanges and mild steel backing rings. Perforated motor cover guards, also manufactured in rigid pvc, can be incorporated in the units as an optional safety measure.

Another feature claimed for the fans is the streamline design of the motor

housing which it is said considerably improves efficiency and at the same time reduces the noise level. The model illustrated is the 18 in size. Development of the range has been in conjunction with Matthews and Yates Limited. *Turner and Brown Limited, Davenport Works, Bolton.*

INDUCTION HEATER

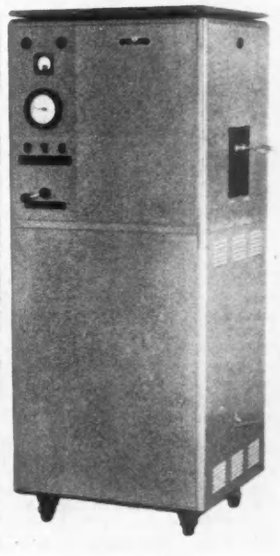
6 kW Medium Impedance Output

A NEW induction heater generator has a continuous output of 6 kW at medium impedance.

It is intended for general purpose work such as annealing, brazing and soldering. Ferrous or non-ferrous loads are possible owing to the high work coil kVA available. The oscillator valve may be either air or water cooled.

The controls, indicator lamps, anode current meter, and process timer are grouped on the front panel. The floor area required is $25\frac{1}{2}$ in by $23\frac{1}{2}$ in. The equipment is self contained with its own timer and protective relays.

The unit is designed to operate from a three phase supply at 360 to 440V 50 cycles with a full load consumption of 12·2 kW. The water consumption for the water cooled version is 2·5 gallons per minute and for the air cooled valve is 0·5 g.p.m. Safety switches are provided behind the movable panels and the components are easily accessible for servicing. *Pye Limited, 28 St. James Street, Cambridge.*



MUD PUMP

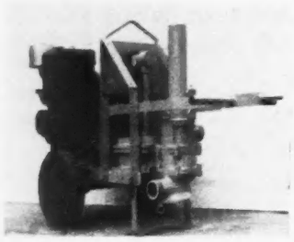
3,600 Gallons per Hour

THE Mark 4 mud pump is capable of a maximum output of 3,600 gallons per hour and of working against heads up to 80 ft.

The pump can be arranged as a mobile unit as illustrated or as a stationary machine. It can also be driven by either an electric motor or by a petrol or diesel engine. The engine normally fitted is the Lister LD1 air-cooled diesel. Alternatives are the Petter PAZ diesel, the Lister L type using petrol, or the Villiers lightweight air-cooled petrol models.

The gearbox is flange mounted to a steel plate member above the pump chamber which greatly strengthens the mounting. The stroke of the pump has been reduced from that of earlier models in order to improve the life of the diaphragm.

The pump body has been designed to have easily cleaned anti-clog ball valves and the chamber is cast on the body instead of being bolted on. Suction and delivery elbows are mounted at one end of the pump and both have three



optional positions enabling both suction and delivery connections to be moved through 180° for convenience in coupling up in awkward positions. The elbows are placed so as to be out of harm's way while the pump is being towed from place to place but are still easily accessible for coupling.

The mobile unit is normally mounted on a two-wheel chassis and provided with a tow hitch for moving about the site or connection to a vehicle. A lifting eye is provided at the point of balance for easy slinging when the pump has to be moved by crane. *C. H. Johnson (Machinery) Limited, Adswood, Stockport, Cheshire.*

PRECISION GRINDER

General Purpose Tool

THE Chambon MSA300 is a precision grinder for cylindrical, internal or external, taper and surface work.

The transverse carriage supports the column which is able to pivot on its vertical axis. The wheelhead is mounted on the column in prismatic slides and moves in a vertical direction, while the wheel spindle can be rotated around its horizontal axis. Both longitudinal and transverse movements are hydraulically operated, thus giving infinitely variable speeds with a rapid retraction on the transverse movement for checking purposes and a rapid return to a dead stop. A micrometer dressing attachment is fitted for the wheel allowing it to be dressed to a preset dimension.

For cylindrical grinding work pieces up to 11⅞ in diameter and 29½ in long can be accommodated, and internal grinding from ⅜ in to 11⅞ in can be carried out over a length of 1¼ in to 4 in according to the type of spindle used. Internal and external grinding can be carried out at the same time. Taper

grinding can be performed by either swivelling the worktable or by indexing the workhead. For surface grinding the capacity is up to 9⅛ in wide by 11½ in thick by 29½ in long. The machine can also be used for grooves, plough grinding, and superfinishing for which a vibrating attachment is available. Power is supplied by a two-speed 3 h.p. motor. *Southern Engineering and Machinery Company Limited, Connaught Buildings, Tanners Brook, Millbrook, Southampton.*

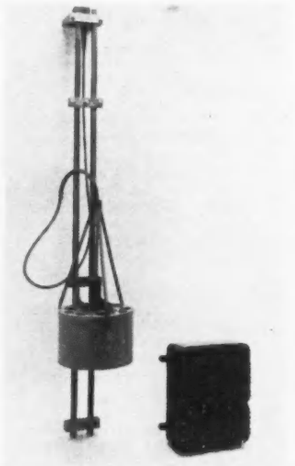
OIL DETECTOR

For Storm Water Tanks

THE apparatus illustrated is designed to give warning when the layer of oil on a storm water tank reaches a certain thickness.

The sensing unit comprises two concentric metal cylinders insulated from each other, with venting holes to allow the escape of air as the liquid level rises. When there is only water between the cylinders there is a virtual short circuit, but when nearly all the water has been displaced by oil the insulation is increased thereby altering the input capacitance to the amplifier and so the output current Under normal conditions the current is of the order of 7mA but when oil is present in sufficient quantity it falls to under 2mA.

The output current is fed to one side of a differential relay which has a reference current of 4·5mA in the second side. The changeover of the relay that results from the fall in current is used to de-energise a solenoid allowing a butterfly valve in the tank outlet to close and so prevent discharge of the



contents until the oil has been skimmed off. *Smiths Industrial Instrument Division, Chronos Works, North Circular Road, London, NW2.*

PORTABLE X-RAY UNIT

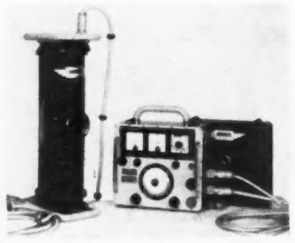
Up to 2¾ in Steel

NOW available in this country is the Andrex portable X-ray equipment weighing only 100 lb.

In its standard form the equipment is suitable for use on steel up to 1½ in thick to Class I standards, but can be used on steel up to 2¾ in thick using fast calcium tungstate intensifying screens. The unit develops 200 kV and provides a tube current of 5 mA.

The tube unit contains the tube, which has a 1·5 mm focal spot, and the high tension transformers. It is shielded to prevent excessive radiation. A built-in cooling pump circulates oil round the transformers allowing a 50 per cent duty cycle; connecting up to an external water supply permits continuous operation. The tube is flexibly mounted to prevent damage during handling. Electrical protection is provided by relays and a thermal switch that cuts out at excessive oil temperatures.

The control unit is housed in a waterproof steel case protected by rubber fenders. The instruments comprise an



illuminated ammeter with line voltage indication, kVp meter, and automatic reset timer with time totaliser. There are indicator lamps for the various supplies and regulation controls for current setting. Protection is given by thermal relay; flashover relay; excess voltage limiter; and blocking switch.

The tube unit measures 29 in long by 12½ in by 8⅛ in and the control unit 7 1/16 in by 15 in by 13¼ in high, without the handle. The tube unit with hand rings weighs 106 lb and the control unit 55 lb; supply and connecting cables add another 13½ lb. *Watson and Sons, (Electro-Medical) Limited, East Lane, North Wembley, Middlesex*

RIVET PRESS

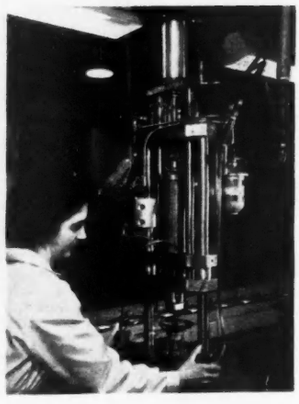
Group Operation

A RIVETING machine now on the market will close groups of semi-tubular rivets simultaneously.

It is claimed that the simultaneous closing of a group of rivets reduces distortion in the component besides speeding up the operation. Since the action is under air power it is less violent than a punch and does not split the ends of the rivets.

Components are loaded on to location pins and clamped by a work holder. Rivets are fed from a Syntron vibratory bowl feeder through flexible tubes to the location pins. Compressed air is used to propel them. Compressed air is also used to operate the independent rams carrying punches which on descent make contact with the heads of the rivets and force the spring loaded locating pins downwards, the rivets then taking the place of the pins.

As they move the hollow shank of each rivet makes contact with a stationary outer sleeve on the pin and is formed into shape. The final operation



is the lifting of the punch rams and work holder to free the component. The only action required of the operator is the loading of the components. After that the operation is automatic when the two push buttons are pressed simultaneously. *Rhoden Partners Limited, 19 Fitzroy Square, London, W1.*

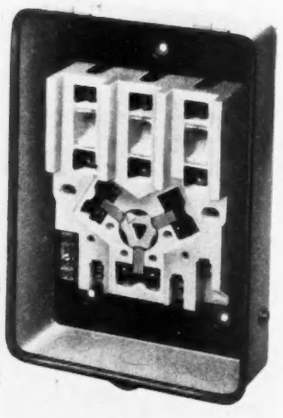
SWITCH FUSES

Slow Break Contacts

CHIEF claim for a new range of switch fuses is that their life is virtually unlimited at full load operation.

The Hidutac range is made in three sizes for 15, 30 and 60A ratings at 440 volts a.c. They can be fitted with either high rupturing capacity or semi-enclosed rewirable fuses. The claim for unlimited life is based on bench tests of 100,000 mechanical operations without failure and 50,000 operations at 50 per cent overload without wear. It is stated that they will repeatedly break up to eight times full load current at their maximum rated horse power for DTL 440V squirrel cage motors.

The performance is achieved by using cam-operated slow break solid silver contacts, the switch element for each phase being separately enclosed to give protection against flashover. The switch mechanism and the fuse bases are moulded in single piece porcelain units which are enclosed in drawn steel cases with pvc gaskets. Operation is by a polystyrene handle on the front. Normal



interlocks are included to prevent opening the cover while switched on. *General Electric Company Limited, Magnet House, Kingsway, London, WC2.*

No Red Flags at Sea

In 1865 the automobile industry had reached a stage comparable to that of nuclear ships today. A few prototype steam-driven motor cars were in operation on the roads and the public was viewing the strange devices with some apprehension, even alarm. The public's alarm, however, was nothing compared to the fright administered to the railways by the appearance of motorised road transport, which was immediately recognised as a potent rival. The railway's collective fright finally crystallised in the second Locomotive Act, which imposed a speed limit on motor cars of 2 miles per hour in town and 4 miles per hour in the country, and ordered that all motor cars must be preceded by a person on foot, bearing a red flag as warning to other users of the road. Last month the Parliamentary committee on the safety of nuclear-powered merchant ships published its report containing recommendations for legislation that will be analogous in function to the Locomotive Act of 1865. But the passage of 95 years has made a tremendous difference in our attitude to things new, potentially hazardous, and as yet untried: the committee's recommendations are as much concerned with ensuring the success of nuclear-powered merchant shipping as preserving public safety.

No Special Status

The parliamentary committee was appointed in March, 1958, to " advise the Minister of Transport and Civil Aviation on the safety problems arising from nuclear propulsion in merchant ships at sea and in port." The present recommendations deal only with surface vessels and make no provision for nuclear-powered cargo submarines. Based on an examination of the operating characteristics of a nuclear reactor and the maximum potential hazards involved in operating a fleet of nuclear powered merchantmen, the committee concluded that it is possible to build nuclear ships with such standards

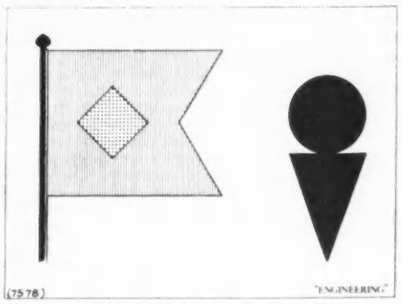


Fig. 1 Burgee (international code letter B with yellow diamond) for nuclear merchantmen in port (left); and signal to be displayed whenever radioactive matter is accidentally discharged (right).

of integrity and handling characteristics that the dangers arising from their operation are comparable to that of other types of commercial surface vessels. This is the key conclusion and serves as the basis of the committee's recommendations: " We are satisfied that by laying down appropriate design criteria and detailed rules, the necessary standard of safety can be achieved, though it *may* be desirable to limit the nuclear ship to selected ports and berths in the *initial* period." (The italics are ours and indicate the committee's confidence.) As a result, the phrase " nuclear ships should have no special status " is a recurrent theme throughout this remarkable document and may be regarded as a tribute to the ability of reactor engineers and naval architects, and the committee's faith in progress.

Twenty Five Rules for Design

The committee's philosophy is reflected in the principles and rules for the design and construction of nuclear-powered ships which form a large portion of the recommendations. In general, the design principles are not much different from those adopted for any nuclear engineering project, and are concerned with problems of fission-product release, shielding, fail-safe control and safety instrumentation. The design principles are put into effect in 25 rules which are intended as an addition to the Ministry of Transport requirements in existence for conventionally propelled ships. The committee emphasise that the recommended rules should not be taken as final or inflexible, but are subject to revision in the light of operating experience. A significant departure from land based practice is the requirement of total containment of the reactor and primary coolant circuit, regardless of reactor type. In land based applications the gas-cooled and the heavy-water moderated reactors have so far been exempt from containment requirements.

Twenty Degree Roll

The requirement that salvage operations should be taken into account when designing ships' reactors is also an interesting departure from land based practice. It is recognised that owing to the hazards of the release of radioactivity it may not be possible to use the usual salvage methods of flame cutting and high explosives, and the maximum lift requirement will not be reducible below a certain minimum represented by the weight of the complete reactor compartment. For the usual marine reactors now proposed, with an output of about 20,000 s.h.p. the minimum weight will probably be in excess of the capacity of commercial salvage equipment, and some sort of arrangement may have to be made to make use of the Admiralty's much heavier lifting machinery. The rules are also explicit regarding the operation of the reactor under conditions of heavy rolling, pitching and permanent list. A 20° deviation from vertical is to be regarded as normal for reactor operation, whether the deviation is periodic or permanent. But the reactor cooling system must be fully operational up to a list of 70°, and the control and shut-down mechanism up to 90°. The control rods must operate automatically whenever the list exceeds 50° and must keep the reactor shut down regardless of the eventual position of the ship, and must operate even after distortion of the reactor vessel.

Three Independent Sources of Power

Auxiliary power for manoeuvring is specified for nuclear ships for two distinct reasons. Where limitations are imposed on the maximum rate of change of reactor power which would restrict the operational flexibility of the propulsion plant, some auxiliary means must be provided to maintain good control over the vessel. To reduce the probability of complete power failure, a minimum of two independent secondary power circuits are specified, arranged so that failure of one will not impede full-power operation of the other. If two independent reactors are installed, or three as in the ice-breaker Lenin, no additional " take-home " power source need be provided, but single-reactor ships such as NS Savannah should have auxiliary power capable of propelling the ship at navigable speeds for at least five days. In order further to safeguard against a ship becoming a casualty through loss of steerageway, the auxiliary power must be available instantly whenever the nuclear ships is in congested or dangerous waters, although appreciable starting time is permitted on the high seas. A further conventional emergency source of power should be provided for lights control gear, and other services.

Warning

Even though the committee's view is to treat nuclear ships as being no different from other vessels whenever possible, certain additional precautions are recommended for their operation. For instance a special signal or sign for nuclear ships is not recommended except under special circumstances. The committee goes a long way to point out that the display of warning signals and some handling restrictions are already imposed on certain classes of vessels, for instance petroleum tankers and ships carrying explosives. The burgee of Fig. 1, a red flag with a superimposed yellow diamond, would be a suitable warning signal to be displayed while a nuclear vessel is in port. The advantage of the signal is that a similar flag is used on petroleum tankers and ships carrying explosives and would be easily recognised by seamen; but has the disadvantage that it deviates from the standard radiation sign used in land based installations, and which will presumably be used around the reactor compartment of the vessel.

Waste Disposal

Another special case when it would be advisable to give warning to ships in the vicinity is when a nuclear ship is discharging radioactive waste not in accordance with internationally accepted arrangements. Such discharge might occur following an accident or might be deliberately precipitated to prevent an accident on board ship. Any fishing vessels, pleasure craft or other ships operating in the area would have to be warned, and the spherical shape over an inverted cone shown in Fig. 1 could serve the purpose. Simultaneously the international code signal *IG* should be flashed, meaning " you should pass to windward of me." If ship has to be abandoned while radioactive matter is being discharged, it will be essential that the crew escape to windward as soon as possible. It is recommended that at least some of the lifeboats be equipped with internal combustion engines; at the same time the substitution of inflatable liferafts for lifeboats is discouraged.

Plans in the United Kingdom

Now that the Galbraith committee have come out in favour of two reactor types for ship propulsion, the boiling-water and the organic-moderated reactor, five companies are busy preparing their tenders. A clarification of the Government's position regarding the favoured reactor types is most welcome, but still requires some statement on the fate of other contending reactor schemes which are now out of the running. (Atomic Review, 22 May, 1959). It is significant that the reactor types chosen are both in a relatively advanced stage of development in land-based power plants, and this may have been a deciding influence in the selection. It would be helpful if the Government could state its position regarding the rejected proposals: have they been rejected because of inherent weaknesses in the reactor system; or only because they were not yet considered ready for prototype construction? The statement would enable designers to review their development programme, and might result in an important realignment within the nuclear industry.

UKAEA Study Corroborates Galbraith Decision

Assuming that the Galbraith Committee's choice of the boiling-water and organic-moderated reactor was based on the prospect of economic operation, the committee's choice has been corroborated by a UKAEA study of five reactor systems. The study was performed during the period January, 1959, to May, 1959, and was presented at the Hamburg

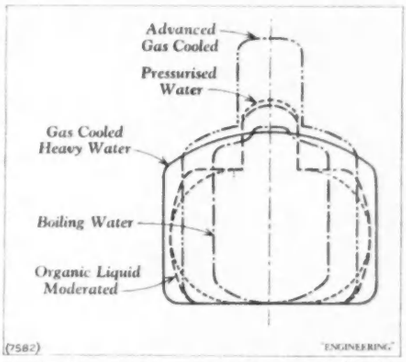


Fig. 2 Outline of five marine reactors of similar output superimposed on one another.

symposium on nuclear propelled merchant ships. All reactor types submitted to the Galbraith committee were covered with the exception of the steam-cooled heavy-water and the high-temperature gas-cooled reactor. A reactor somewhat similar to the steam-cooled heavy-water system, the gas-cooled heavy-water moderated reactor, was however included. Using uniform design criteria and methods of economic evaluation it was found that the lowest operating costs could be expected from the boiling-water and organic-moderated reactors—still 29 to 37 per cent higher than produced by conventional propulsion. Operating costs of the advanced gas-cooled reactor were as much as 56 per cent higher in this particular design study. Fig. 2 shows superimposed the containment vessels of the five reactors.

Shipowners' Consortium

The question of what to do with a marine reactor that might be built as a result of tenders invited for boiling-water and organic-liquid moderated reactors is still an open question. The project is now under

Continued on next page

the control of the Ministry of Transport and a naval application seems out of the question, although Mr. Orr-Ewing, Civil Lord of the Admiralty, has indicated on several occasions that a second nuclear submarine is planned and a nuclear surface ship is under study. Sir Nicholas Cayzer, president of the United Kingdom Chamber of Shipping, is urging the Government to shoulder a substantial part of the development costs and thinks it incongruous that while backing of an aircraft programme is accepted practice, the Government should hesitate to give its full support to a nuclear-ship project. At the end of January the Chamber of Shipping made a list of names available to the Ministry of Transport, containing parties interested in forming a consortium. Although the list has not been made public, the oil companies are believed to be well represented. Oil tankers, which are coming off the ways in increasing sizes, are perhaps the most suitable as a first application for a nuclear reactor owing to the regularity of their service and the nature of their cargo. But even when the most fortuitous combination of reactor, ship, and shipping route, the nuclear ship is expected to be at least 30 per cent more expensive—or less profitable—to operate than the conventional competitor. At the second Geneva conference, when details of the nuclear icebreaker Lenin were discussed, someone had remarked that the Russians had undoubtedly hit upon the ideal application, the only application where the expense of a reactor plant could be justified in terms of straight economics. Britain not having much of an ice problem but still wishing to develop nuclear propulsion must somehow pay the costs.

Goodwill at Portland

USS Skate made a four-day good will visit to Portland, during which British experts had an opportunity to discuss handling problems of nuclear ships with members of the crew.

Notes and News

Reactor Notes

Recruitment for AGR: The UKAEA is recruiting a team of scientists and engineers to perform physics and metallurgical studies in connection with the advanced gas-cooled reactor project.

Approval for Yankee: Nucleate boiling and the use of boric acid as a burnable poison in the Yankee Atomic Electric Company's 110 MW(e) boiling-water reactor have now received official approval.

Exchange on Dragon: Full exchange of information on high-temperature reactor development has been proposed between the USAEC and the board of management of the OEEC Project Dragon.

Gift to Indonesia: The Soviet Union has agreed to supply a research and training reactor to Indonesia as part of a large foreign-aid plan for underdeveloped countries.

Critically Heralded: Aldermaston's material testing reactor Herald was brought to criticality for the first time last week.

Hunterston Service Machine

The Hunterston reactors will use a charge machine operating from below the pressure vessel, leaving the area of the top shield free for maintenance operations. A service machine is installed above this floor capable of performing all normal reactor maintenance duties, together with a number of emergency operations. With few exceptions, these operations can be carried out with the reactor under pressure and on load. The machine consists essentially of six specialised units contained in a pressure vessel, which is mounted on a movable bridge with longitudinal and cross travel, so that it can be positioned over any one of the 208 standpipes connecting with the reactor. Two identical units are used for control-rod and motor replacement, another pair are used for removal of distance tubes and control rods in the event of cable breakage, one carries a set of telescopic tubes for the insertion of thermocoupled fuel elements, and the sixth has telescopic tubes to link with any fuel channel for more general purposes, such as the insertion of a television camera. The pressure vessel shown in Fig. 3 takes the form of a stepped cylinder, 44 ft long and 11 ft in diameter at its larger end. It is supported on the bridge by screw jacks, and hydraulic jacks enable its vertical position to be adjusted within limits. Construction and testing of this service machine will form the first of a series of such projects, the test pit and its associated structures having been designed to accommodate two of the three Hunterston charge machines and one of the two service machines at the same time. The pressure vessel for the service machine was fabricated by the Motherwell Bridge and Engineering Company Limited for the GEC—Simon-Carves Atomic Energy Group.

Precision Engineers Take Over at Berkeley

Laying of the graphite courses in the pressure vessel of Berkeley nuclear power station has started and is to proceed at the rate of one layer per week (Fig. 4). In spite of certain design changes caused by the emergence of Wigner shrinkage, construction is on schedule and the necessary modifications to the restraint garters have been carried out. The pressure vessel is now air-conditioned and strict control of all materials entering the reactor is enforced, including frisking all persons for cigarettes, lighters and rings. The first graphite course is supported on ball bearings and an expendable centring device is used to ensure correct alignment of the bearing components while the graphite is placed. The device is later removed from below by collapsing the thin metal. A set of channel gags is placed into position at this stage. Later they may be changed by means of the fuel handling machinery to adjust the core temperature distribution. Clean condition facilities are installed in the instrument annexe of the reactor building and consist of several air locks and a tortuous air path of labyrinthine passages formed with wooden board and sealed at all cracks. Civil engineering has reached the final stages and some John Laing engineers expect to be moved to other jobs in about two or three weeks time. Dismantling of the erection equipment has already begun and only one monotower crane is left to guard No. 1 reactor. In the turbine hall the first turbine is already erected and the generator stator has just arrived at the site. On the other turbines tubing of the condensers is now in progress.

Paints for Clean Conditions

Special paints suitable for use inside reactor vessels and in clean-condition workshops have been developed. A feature of the paints is that neutron absorbing materials are kept to a specified low value so that the neutron physics of a reactor will be little affected by the application of a coat of paint. A development of Federated Paints Limited of Glasgow,

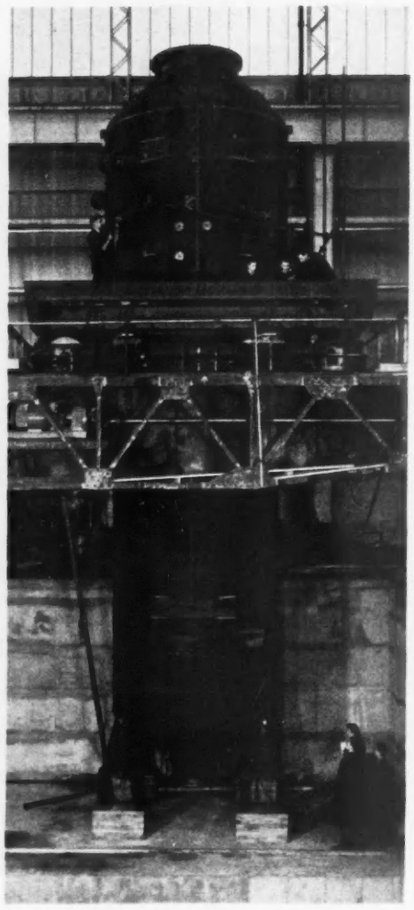


Fig. 3 Servicing machine for the Hunterston reactor erected in the shop for testing its six independent functions.

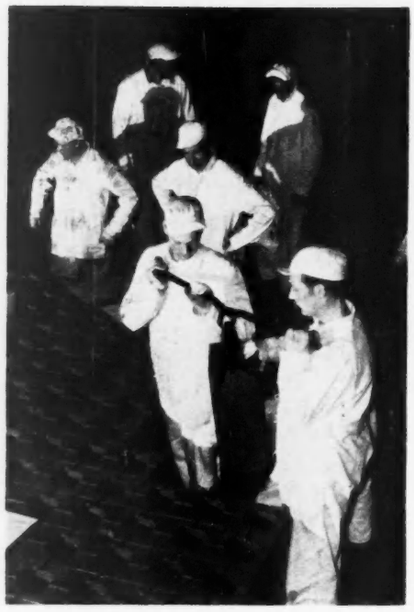


Fig. 4 Laying graphite moderator courses in the Berkeley nuclear power station.

the Alkalad range is recommended for use on floors and walls of clean-condition shops and change-rooms, while Strathclyde paints are intended for use on the reactor components themselves. The paints allow for easy decontamination and have received UKAEA approval.

Detergent for Decontamination

A detergent specially compounded for the removal of radioactive metals and their salts has been developed by the UKAEA and is to be manufactured under licence. The detergent can deal successfully with contamination even when it has become chemically bound to working surfaces or to clothing, and prevents re-adsorption during rinsing. Cream is used for the decontamination of large surfaces such as ships or aircraft, and abrasives can be added to increase the effectiveness where contamination has penetrated into the metal surface. The cream is applied by brushing and kept moist by a light water spray. Hot water or wet steam is used to dilute and remove the detergent. In one test aluminium and stainless steel surfaces contamined with a plutonium salt solution and a cerium 144 salt solution were exposed to the detergent for 15 minutes at room temperature. At the end of the test, the plutonium contamination had been reduced to 0·5 per cent on aluminium and 0·8 per cent on stainless steel, while cerium contaimination had dropped to 0·2 per cent, and on stainless steel to 3·2 per cent.

New Division for Research Reactors

A special division for the operation, maintenance and development of research reactors has been formed at Harwell, and will be in charge of the reactors DIDO, PLUTO, LIDO, BEPO, GLEEP, and the operation of DIMPLE. In addition to operating the reactors, the division will undertake physics experiments necessary for the solution of design and operation problems and studies on possible future research-reactor systems. Acting head of the division will be Mr. W. F. Wood.

Sic Itur ad Museum Scientiarum

Museums are repositories of antiquities, and it is a sign of our times that a piece of equipment that was the newest in 1957 should find a place in the Science Museum in 1960. But that is the fate of OSWALD, one of the first fast-pinch devices used in Britain in the search for thermonuclear reactions, which has now been sent on permanent loan to Kensington from the Atomic Weapons Research Establishment at Aldermaston. Oswald's condenser banks were capable of delivering current with a rate of rise only $1{\cdot}2 \times 10^{12}$ amperes per sec, which clearly just wouldn't do any longer. The new machine, MAGGI, has since rendered Oswald obsolescent with a current rate of rise five times Oswald's best (Atomic Review, 29 May, 1959), so that the latter can now look forward to several centuries of quiet contemplation about the passage of glory.

The

'Engineering' Appointments

Section

WORCESTERSHIRE COUNTY COUNCIL
COUNTY SURVEYOR'S DEPARTMENT
RESIDENT ENGINEERS ETC.

Applications are invited for the following appointments, primarily in connection with supervision of contract work on a 28-miles length of the Bristol-Birmingham Motorway, including 63 bridges:—

(*a*) **CHIEF PROJECT ENGINEER.** Scale F (£1790-£2085).
(*b*) **SENIOR RESIDENT ENGINEERS.** Scale C (£1385-£1620).
(*c*) **SENIOR ASSISTANT PROJECT ENGINEER** (Land, Accommodation Works, Measurements, Claims). Scale B (£1310-£1485).
(*d*) (i) **SECTION ENGINEERS.** Scale B (£1310-£1485).
(ii) **SECTION ENGINEERS.** Scale A (£1215-£1390).
(*e*) **RESIDENT ENGINEERS** (Measurements and Claims). Scale A (£1215-£1390).
(*f*) (i) **ASSISTANT SECTION ENGINEERS.** APT. V (£1220-£1375).
(ii) **ASSISTANT SECTION ENGINEERS.** APT. IV (£1065-£1220).
(iii) **ASSISTANT SECTION ENGINEERS.** APT. III (£880-£1065).
(*g*) (i) **ASSISTANT RESIDENT ENGINEER** (Site Soils Laboratory). APT. IV (£1065-£1220).
(ii) **ASSISTANT RESIDENT ENGINEER** (Site Soils Laboratory). APT. III (£880-£1065).
(*h*) **GRADUATE ASSISTANTS.** APT. I (£610-£765).
(*j*) **LABORATORY TECHNICIANS.** Misc. VI (£715-£775).
(*k*) **DRAUGHTSMEN.** Misc. VI (£715-£775).
(*l*) **CLERKS OF WORKS.** £1000 per annum.
(*m*) **INSPECTORS.** £750 per annum.

The appointments are superannuable, and for a period of approximately two years. Conditions of Service are those of the appropriate National Joint Council. "Essential user" scales of car allowances and subsistence allowances at "outside officer" rates will be payable for most of the engineering appointments. Certain site allowances will also be payable for weekend inspections. The County Council will consider the payment of a proportion of furniture removal expenses, and may be able to offer temporary housing accommodation in a few instances.

Candidates for the engineering posts must have had suitable road or bridge design and construction experience, and qualifications proper to the appointment sought.

Graduate Assistants must possess an appropriate Degree, but applications from men now in their final University year would be considered.

Laboratory Technicians should have had appropriate practical experience in the sampling and testing of soils and road materials.

Draughtsmen should be experienced in road and bridge work detailing and should preferably be conversant with the use of surveying instruments

Clerks of Works and Inspectors must have had previous experience in these respective positions on large-scale road or bridge contracts.

Previous Local Government experience is not essential for any of the posts.

Applications should be submitted AS SOON AS POSSIBLE to the **COUNTY SURVEYOR, COUNTY BUILDINGS, WORCESTER,** in the following form: Appointment and Grade sought; Name; Age; Theoretical Qualifications; Present Appointment, Grade and Salary; Previous Appointments and Experience; Whether Car-owning; When Available; Particulars of two Referees. (X.24) B 520

PUBLIC APPOINTMENTS

DRAUGHTSMAN

Applications are invited for the above post, which is located in Birmingham.

The work is interesting and varied and is mainly in connection with the design of industrial heating equipment. A knowledge of combustion technique and the use of refractories would, therefore, be an advantage.

Candidates should possess the Ordinary National Certificate in Mechanical Engineering as a minimum qualification.

The salary for the appointment, which is pensionable and subject to medical examination, will be within the range of £733-£853 per annum.

Applications, stating age, qualifications and experience, together with the names of two referees, should be addressed to the INDUSTRIAL RELATIONS OFFICER, WEST MIDLANDS GAS BOARD, 6, AUGUSTUS ROAD, EDGBASTON, BIRMINGHAM, 15. G 848

CROYDON
THE COUNTY BOROUGH OF CROYDON
EDUCATION COMMITTEE

Invite applications from suitably qualified persons for the following additional posts in the Mechanical Engineering Department:—

CROYDON TECHNICAL COLLEGE
FAIRFIELD, CROYDON

Principal: D. A. GREEN, M.B.E., B.Sc., M.Ed.

1. LECTURER. Candidates should be University Graduates in Mechanical Engineering with appropriate industrial experience and should indicate which of the following subjects they are able to offer to Higher National Diploma level: Metallurgy, Theory of Machines, Strength of Materials, Engineering Production.

2. ASSISTANT (GRADE B). Candidates should possess good academic and professional qualifications. The duties will include the teaching of Mechanical Engineering subjects to the level of an Ordinary National Certificate.

3. ASSISTANT (GRADE A). Two posts. The duties will include the teaching of Craft Science and Technology, together with Workshop Practice in one or more of the following subjects: Motor Vehicle Work, Welding, Heating and Ventilating Operative Work, Machine Shop Engineering.

Salaries within the scale: Lecturer £1370-£1550 per annum; Grade B £700-£1150 per annum; Grade A £520-£1090 per annum; plus London Area Allowance of £38 or £51 per annum in all cases, and appropriate allowances for degrees, training and experience for Grade A and B posts.

Further particulars and forms of application may be obtained from the CHIEF EDUCATION OFFICER, EDUCATION OFFICES, KATHARINE STREET, CROYDON, and should be returned to THE PRINCIPAL within 14 days of the appearance of this advertisement. B 516

AIR MINISTRY

AIR MINISTRY Works Designs Branch requires in LONDON and PROVINCES ENGINEERING DESIGNER DRAUGHTSMEN experienced in preparation of pipework and mechanical and electrical plant layouts. Candidates should have served recognised apprenticeship or had equivalent training and also have had practical experience. O.N.C. an advantage. Financial assistance and time off given for recognised courses of study. Promotion and pension prospects. Five-day week with 18 working days leave per year initially. Overseas tours for which special allowances granted.

Salary in LONDON ranges from £680 (at age 25) to £900 p.a. for men; from £673 to £968 p.a. for women. Somewhat lower in PROVINCES. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.c., LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange (quoting Order No. Kings Cross 3743), giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 846

AIR MINISTRY

AIR MINISTRY require STATION ENGINEERS (G.D.) and STATION ENGINEERS (MECH.) at R.A.F. and M.T.C.A. Stations. The work of Station Engineer (G.D.) consists of installation, operation and maintenance of high and medium voltage electrical distribution systems, electrical power and lighting installations, control systems and generating plant: knowledge of heating and ventilating plant and diesel engines an advantage. Station Engineer (Mech.) are concerned with diesel power plant, steam and hot water heating systems, refrigeration and air conditioning and miscellaneous workshop plant, tools and equipment. Commencing salary according to age, qualifications and experience. Salary ranges £680 to £850. Candidates must hold O.N.C. Electrical or Mechanical/City and Guilds Electrical Technicians Certificate/2nd Class M.O.T. Certificate, or equivalent, and must also have had recognised apprenticeship with firm of good repute plus 3 years' employment in electrical or mechanical and engineering, preferably on operation and maintenance of mine, factory or workshops plant and services. Preference to candidates with supervisory experience. Opportunities for promotion up to Technical Grade A, maximum salary £1565 (National Rate) and pension prospects. Five-day week, three weeks three days leave a year initially. Internal training courses are provided and attendance at technical colleges by suitable candidates is sponsored. Overseas tours for which special allowances are payable in addition to higher salary. Applications normally from natural born British subjects only, up to age 55 years. —Write, stating age, qualifications and experience, to MANAGER (P.E.1), PROFESSIONAL AND EXECUTIVE REGISTER, MINISTRY OF LABOUR, ATLANTIC HOUSE, FARRINGDON STREET, LONDON, E.C.4. No original testimonials should be sent. Only applicants selected for interview will be advised. G 845

BRITISH STANDARDS INSTITUTION
TECHNICAL STAFF

The B.S.I. invites applications from

MECHANICAL ENGINEERS

to join the technical staff of the Institution. This staff is responsible for the work of the Institution in the preparation of British Standards in co-operation with the various sections of industry and is required to plan and progress the work. They act as secretaries to technical committees.

Applicants should have a university degree or equivalent professional qualification in mechanical engineering.

There are three grades of appointment and salaries in the top grade range up to £2,000 plus; applications, however, are invited for the junior grade, the starting salary being dependent on individual qualifications and experience. The posts are pensionable.

Apply to the
ESTABLISHMENT OFFICER,
B.S.I., 2, PARK STREET,
LONDON, W.1 B 522

AEI

QUALIFIED ENGINEER

for service in India.

Wide knowledge and experience of the machine tools and tooling used in the medium/heavy engineering industry essential.

Applicants should have a knowledge of British, Continental and American machine tools, and be able to inspect and report on suitability, accuracy and workmanship of any manufacturer's machine in relation to a specific production requirement. He must also be able to inspect machines and equipment on arrival on site for completeness, or damage; to supervise installation and lining up, and the commissioning of machines and their tooling for specific jobs.

Three year contract in first instance. Salary up to £2400, free housing and services, free medical attention, use of car, first class passages each way for engineer and family and other valuable advantages.

Apply stating age, qualifications, experience, family circumstances and names of references to:—

SECRETARY, A.E.I. OVERSEAS LIMITED
33 Grosvenor Place · London, S.W.1. B 527

MECHANICAL *Engineers*

JOSEPH LUCAS (ELECTRICAL) LIMITED

have vacancies in their laboratories for Senior Technical Assistants to work on a wide range of investigations associated with the performance of internal combustion engines including starting at low temperatures. Applicants should have had previous engine experience, preferably including engine testing, and be of Higher National Certificate standard.

The posts are permanent and pensionable. Five-day week.

Apply in writing, stating age, qualifications and experience, to the PERSONNEL MANAGER, JOSEPH LUCAS (ELECTRICAL) LIMITED, GREAT KING STREET, BIRMINGHAM, 19, quoting reference PM/D 417 B 534

ROLLING MILL ENGINEER

A leading United Kingdom Iron and Steel Company requires an Engineer to take control of the Rolling Mill Section of its current large development programme. This is an important position, offering great scope for initiative and requires an Engineer with special qualifications and ability. A sound design and operational background in this field is essential.

Terms of service and other conditions are attractive and the housing situation is good. There is a Staff Pension Fund and Life Assurance Scheme.

Applications, which will be treated as confidential, should be sent to BOX B 530, Offices of ENGINEERING.

ELECTRICAL ENGINEERS

Electrical Engineers are required by one of the leading manufacturers of Iron and Steel, to assist with the electrical engineering side of a large development programme. Candidates must have a good theoretical background and possess a degree or an equivalent qualification. Wide practical experience in manufacturing industry an advantage. Experience in iron and steel industry and particularly on Continuous Mills would be an asset.

Terms of service and other conditions are attractive and the housing situation is good. There is a Staff Pension Fund and Life Assurance Scheme.

Applications will be treated in complete confidence and should be addressed to BOX B 529, Offices of ENGINEERING.

COUNTY BOROUGH OF HUDDERSFIELD
TRAINING COLLEGE FOR TECHNICAL TEACHERS
LABORATORY TECHNICIANS

Applications are invited for the posts of LABORATORY TECHNICIANS, one for Science subjects and two for Engineering subjects (one Electrical and one Mechanical), at the above College. The persons appointed will be expected, in addition to maintaining equipment, to be able to develop and make items of laboratory equipment from design sketches.

Salary scale: £650 by £20 by £25 by £20 to £715.

Further details may be obtained from the DIRECTOR, TRAINING COLLEGE FOR TECHNICAL TEACHERS, HOLLY BANK ROAD, LINDLEY, HUDDERSFIELD, to whom letters of application giving age, qualifications, present position, previous experience and names and addresses of two referees, should be submitted as soon as possible.

H. GRAY,
Chief Education Officer.
B 507

THE UNIVERSITY OF LIVERPOOL
LECTURER

Applications are invited for the post of LECTURER in the DEPARTMENT OF FLUID MECHANICS. The initial salary will be within the range £900-£1650 per annum, according to age, qualifications and experience. Candidates should have an Honours degree, or its equivalent.

Applications, stating age, academic qualifications and experience, together with the names of three referees, quoting Ref. CV/EN, should be received not later than 26th March, 1960, by the REGISTRAR, from whom further particulars of the conditions of appointment may be obtained. B 504

AIR MINISTRY

AIR MINISTRY Works Designs Branch requires in LONDON CIVIL ENGINEERING DESIGNER DRAUGHTSMEN with adequate training and drawing office experience in one or more of the following:—(*a*) Roads, pavements, earthworks and stormwater drainage; (*b*) Foul drainage and sewage disposal; (*c*) Water supply and distribution. Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 working days leave per year initially.

Salary ranges from £680 (at age 25) to £900 p.a. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.c, LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange (quoting Order No. Kings Cross 3746) giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 840

ADMIRALTY

ADMIRALTY require temporary PRODUCTION ENGINEERS in Establishments, mainly in South of England. Duties cover variously production of mechanical, electrical and electronic equipment, including radar and guided missiles, design for production, advice on production methods and preparation of estimates. Must have served recognised apprenticeship or equivalent training, and possess University Degree, A.M.I.Mech.E., A.M.I.E.E., or exempting qualifications. Age not less than 25. Salary range £780 at 25 to £1215. Starting salary according to age up to £1055 at 34.—Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting C.188/OA. Closing date 25 March, 1960. B 540

ROYAL TECHNICAL COLLEGE, SALFORD
DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the following Readerships in this College of Advanced Technology:—
READER in Applied Mechanics
READER in Applied Thermodynamics
READER in Production Technology.

Applicants should have good academic qualifications and research experience showing proven ability in fundamental or applied research in the appropriate field. Industrial and teaching experience will be additional qualifications.

The main task of each successful candidate will be to develop research in his subject; he will also be expected to carry out a very limited amount of teaching in appropriate subjects. Excellent facilities and equipment for research are being acquired. Staff are encouraged to engage in private consulting work subject to reasonable safeguards.

The salary scale is £1800 rising to £2100 per annum; exceptionally, a higher maximum may be fixed. Appointments may be made at any point within this scale, up to the maximum, depending upon the candidate's experience.

Further particulars and forms of application may be obtained from the REGISTRAR, ROYAL TECHNICAL COLLEGE, SALFORD 5, LANCS., to whom applications should be sent by Monday, 4th April, 1960.

R. RIBBLESDALE THORNTON,
Clerk to the Governors. B 538

AIR MINISTRY

AIR MINISTRY require ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS for design, construction and maintenance of installations on airfields, radar stations, missile bases, workshops and maintenance units for R.A.F. at home and overseas as well as certain Civil Airports. Salary: £805 at 25 to £1095 at 34 or over, thereafter rising to max. £1260 with increase for London and slight decrease for country districts. Appointments non-pensionable but long term. Promotion prospects. Five-day week with 4 weeks 2 days leave a year initially. Special allowance in addition to salary during overseas service. Quals. and experience:—

(i) (*a*) University degree or equiv. diploma in electrical and/or mechanical engineering with at least 2 years apprenticeship; or (*b*) Graduate or corporate member of I.E.E. with at least 3 years apprenticeship; or (*c*) Graduate or corporate member of I.Mech.E. appreciable electrical engineering experience with at least 3 years apprenticeship; and

(ii) Have been employed for minimum of 2 years with well established engineering concern and gained wide experience in both electrical and mechanical engineering practice.

Applicants must be natural born British subjects between ages of 25 and 45.

Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting D.158/OA. B 531

DERBY AND DISTRICT
COLLEGE OF TECHNOLOGY

Applications are invited for the post of WORKSHOP INSTRUCTOR to teach practical foundry work and patternmaking in the Apprentice Training School. Applicants should have good practical experience in these subjects and, preferably, a City and Guilds Certificate or similar qualification. Salary £520-£1000 and up to 12 increments for approved industrial experience.

Forms of application and further particulars may be obtained from the PRINCIPAL, DERBY AND DISTRICT COLLEGE OF TECHNOLOGY, KEDLESTON ROAD, DERBY, by whom completed applications should be received within two weeks of the appearance of this advertisement. B 526

UNIVERSITY OF HONG KONG

Applications are invited for the following posts:

1. LECTURESHIP IN MECHANICAL ENGINEERING

Applicants should hold a degree in mechanical engineering from a British University, or its equivalent, preferably with first or second class honours, and must be Corporate Members of the Institution of Mechanical Engineers. Preference will be given to applicants who have experience of teaching at University level and/or of research work.

The successful applicant will be required to lecture in Machine Design and Production Engineering and may be required also to assist in other courses. He will be expected to engage in research. The successful applicant will be requested to commence duties in September, 1960.

2. LECTURESHIPS (2) IN ELECTRICAL ENGINEERING

Applicants should hold a degree in electrical engineering from a British University, or its equivalent, preferably with first or second class honours, and must be Corporate Members of the Institution of Electrical Engineers. Preference will be given to applicants who have experience of teaching at University level and/or of research work.

The successful applicants will be required to lecture in (*a*) Electrical Machines and Electrical Measurements; (*b*) Light Current Electrical Engineering and Applied Electronics; they may also be required to assist in other courses. They will be expected to engage in research. Successful applicants will be requested to commence duties in September, 1960.

Annual salary (superannuable) is £1575 by £50 to £2175 for a man or £1200 by £40 to £1680 for a woman. There is also an expatriation allowance of £225 a year if applicable. The equivalent of income tax in the Colony is comparatively low.

First class sea passages are provided for expatriate staff and their families on first appointment and leaves. Accommodation at reasonable rental is provided for those receiving expatriation allowance.

Further particulars and information as to the method of application may be obtained from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 GORDON SQUARE, LONDON, W.C.1.

Applications close, in Hong Kong and London, on 15th April, 1960. B 542

ADMIRALTY

ADMIRALTY NAVY WORKS DEPARTMENT require MECHANICAL ENGINEERS at Pinner (Middlesex) and Portsmouth, Liverpool, Glasgow and Rosyth. Qualifications: Corporate Members of Institution of Mechanical Engineers. Work comprises design and supervision of mechanical services in Admiralty Shore Establishments (except Royal Dockyards), such as Heating, Ventilating, Air Conditioning, Cranes, Machine Tools, Civil Engineering Plant, etc. Candidates should be at least 32 years of age, and have experience in this or similar work. Salary range from £1285 to £1730 (National Rate); rates vary slightly according to location. Appointments unestablished but opportunities later for establishment. Prospects of promotion and opportunities for service overseas.—Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26 KING STREET, LONDON, S.W.1, quoting C.190/OA. Closing date 25 March, 1960. B 541

'ENGLISH ELECTRIC'

AVIATION LIMITED

AIRCRAFT DIVISION - LYTHAM ST. ANNES

Now is the time to secure your future in the NEW AIRCRAFT INDUSTRY with responsibilities in developing the new generation of Civil Aircraft backed by extensive Military Contracts, including considerable development of the Lightning and the new T.S.R.2. There is probably a post with increased responsibilities for you in one of the following categories:—

MECHANICAL ENGINEERS

- Structural Design, Stress Analysis, Airworthiness.
- Internal Flow and heat transfer.
- Development of mechanical systems.
- Aeroelasticity.
- Development Engineers.
- Weight Control Engineers.

AERODYNAMICISTS & MATHEMATICIANS

- Flight Test Engineers with a minimum qualification to H.N.C. level.
- Computer Programmers.
- Aerodynamicists for control stability and performance calculations.
- Fluid flow specialists.
- High speed wind tunnel engineers.

ELECTRICAL ENGINEERS

- Theoretical Design of aircraft electrical systems.
- Development of electrical components.
- Development of Automatic Flight Systems.
- Electronic Engineers for development of "one off" control systems.
- Electrical and Electronic technicians to operate comprehensive test rigs.

AIRCRAFT DESIGN DRAUGHTSMEN

For these vacancies applicants must have 3 years' experience in an aircraft D.O. and be engaged on design work.

- Electrical installations.
- Engine equipment and control installations.
- Structural Design and engine installation.
- Power controls.
- Mechanical design, e.g. undercarriage design, control boxes, escape facilities
- Flight test instrumentation.

If you are interested in one of these subjects and would like to make an appointment to discuss these opportunities on an informal basis, we invite you to write in confidence to Dept. C.P.S., Marconi House, 336/7, Strand, W.C.2, quoting reference EG 1716C, giving details of your qualifications and experience and indicating your particular interest.

Appointments will be arranged by the Aircraft Division to suit your convenience, and we will endeavour to meet you at a centre within easy access to your home.

All appointments will be permanent and pensionable, after a qualifying period, and assistance with removals and housing will be given in certain cases.

B468

JOSEPH LUCAS (ELECTRICAL) LIMITED

There are vacancies for

DESIGNERS & DRAUGHTSMEN FOR LIGHTING DEPARTMENT

to work on mechanical design of a wide range of lamps for new car models. The work involves the application of pressure diecasting, pressing and plastic moulding techniques for large quantity production and some experience in one of these fields would be an advantage.

Applicants should have Higher National Certificate, but consideration will be given to men with Ordinary National Certificate and suitable experience. The posts are permanent and pensionable, and a good starting salary will be paid. Five-day week.

Apply in writing, stating age, qualifications and experience, to the **PERSONNEL MANAGER, JOSEPH LUCAS (ELECTRICAL) LIMITED,** Great King Street, Birmingham, 19, quoting Reference PM/D/420. B 515

PLANNERS/RATEFIXERS AND ESTIMATORS

FOR SOUTH AFRICA

Leading Heavy Engineering Works in South Africa requires PLANNERS/RATEFIXERS AND ESTIMATORS.

Applicants must have served a fully recognised apprenticeship as Fitters and Turners and must have thorough experience of this type of work.

Minimum inclusive salary £1150 per annum, but salary will be paid according to qualifications and experience. Good prospects for the right persons.

Housing available. Pension and Medical benefit funds. Facilities exist for advancing travelling expenses to South Africa on contract basis.

Write, stating age, qualifications, present salary, previous experience and marital status, to

BOX 102,
c/o WALTER SKINNER, LTD.,
20, COPTHALL AVENUE,
LONDON, E.C.2 B 517

G.E.C.

has the following vacancies in the

OSRAM LAMP DIVISION

NORTH WEMBLEY

DESIGN ENGINEERS & DESIGNER DRAUGHTSMAN

To join group engaged in the design and special purpose machinery and fine mechanisms for mass production of light engineering products. The work is interesting, gives scope for initiative and has excellent prospects. Applicants should have a minimum of H.N.C. Mech. Eng., and preferably some experience in mechanical design.

DETAIL DRAUGHTSMAN

This vacancy has arisen on similar type of work. Applicant should have O.N.C. Mech. Eng., and preferably Drawing Office experience.

These appointments are permanent and pensionable for the right applicants.

Applications, giving full particulars of experience and qualifications, should be sent to:—

THE SENIOR PERSONNEL OFFICER,
OSRAM LAMP DIVISION
NORTH WEMBLEY.

B 514

GOSS OF PRESTON

GOSS PRINTING PRESS COMPANY LIMITED

manufacturers of large printing presses, have immediate vacancies for

3 SENIOR DRAUGHTSMEN

These vacancies are due to the Company expanding resulting in numerous promotions.

The successful applicants should have experience in the design of Machine Tools. At least Ordinary National Certificate qualifications is a necessity.

Excellent conditions of employment including five-day week, Pension and Life Assurance Scheme, Annual Bonus.

Applications stating full details of age, experience and qualifications, to be addressed to the

PERSONNEL MANAGER
GREENBANK STREET, PRESTON

Telephone No. 57571
Quoting Ref. No. PD85. B 521

MECHANICAL ENGINEER-DESIGNER

required by

SIR ROBERT McALPINE & SONS LTD

to work from their London Office

Experience in Civil Engineering Plant preferred, but not essential.
Minimum standard H.N.C.
Age about 35

Salary according to experience.
Bonus payable

Apply, in writing, to

80 PARK LANE, LONDON, W.1.

B 524

ADMIRALTY

ADMIRALTY require NAVAL ARCHITECTS for unestablished posts as Senior Design/Design Assistants in Ship Department, Bath. British subjects with University degree (or equiv.) in Naval Architecture and practical shipyard experience. Salaries for two available grades assessed according to age, qualifications and experience, to maxima £2255 and £1330 respectively. Only exceptionally well qualified candidates considered for higher grade. Five-day week.—Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting C.339/9A. Closing date 14 April, 1960. B 533

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF CIVIL ENGINEERING

RESEARCH ASSISTANT required for an investigation into the behaviour of skew slab bridges. Candidates should possess an Honours Degree in Engineering, Mathematics or Physics. Salary within the range £700 to £850 p.a. with Superannuation benefits and Children's Allowances. Conditions of appointment and form of application, which should be returned by 4th April, 1960, from the REGISTRAR. B 546

QUEEN MARY COLLEGE

(UNIVERSITY OF LONDON)

Applications are invited for the post of LECTURER or ASSISTANT LECTURER IN MECHANICAL ENGINEERING. Salary Scales: Lecturer £900 by £50 to £1350 (efficiency bar); £1425 by £75 to £1650. Assistant Lecturer £700 by £50 to £850, plus London Allowance of £60, F.S.S.U. participation and family allowance of £50 for each child. Initial salary according to qualifications and experience.

Application forms, obtainable from the REGISTRAR, QUEEN MARY COLLEGE, MILE END ROAD, E.1, to be returned by March 31st. B 544

NATIONAL COLLEGE FOR HEATING, VENTILATING, REFRIGERATION AND FAN ENGINEERING

BOROUGH POLYTECHNIC,
BOROUGH ROAD, LONDON, S.E.1

Director: JAMES E. GARSIDE, M.Sc.Tech., Ph.D., F.R.I.C., F.I.M., F.Inst.F.

Head of College: DAVID R. SCOTT, M.Sc., Ph.D., M.Inst.R., A.M.I.H.V.E., A.Inst.P., A.M.I.Min.E., A.M.E.M.E.

The Governors invite applications for the following appointment:—

RESEARCH ASSISTANT

Applicants should be University Graduates in Science or Engineering. Consideration will also be given to those expecting to graduate at the end of this present academic year. Applicants should have a knowledge of Automatic Controls and an interest in Process Control Engineering. Where a candidate's qualifications permit, the results of the research may be used for the purpose of gaining a higher degree. Publication is encouraged.

Salary £600 p.a., and the post is superannuable after an initial period of one year.

Further particulars and Application Form, which should be returned as soon as possible, obtainable from the undersigned.

FREDK. J. PACKER,
Clerk to the Governing Body. B 549

THE COLLEGE OF AERONAUTICS

ONE YEAR POST-GRADUATE COURSE IN FLUID MECHANICS 1960-61

A one year post-graduate course in "Fluid Mechanics" will be held at the College during the Autumn, Spring and Summer terms of the academic year 1960-61.

The course is intended for students wishing to acquire a knowledge of fluid mechanics at an advanced level without necessarily specialising in aeronautics. Applicants must be graduates in a branch of science or engineering and have had practical experience in one of the subjects covered by the course.

The content of the course includes the general theory of fluid flow at subsonic, supersonic and hypersonic speeds, high temperature gas dynamics and hydromagnetics, project work, experimental facilities and techniques and specialised aspects of ship hydrodynamics (including cavity flows, behaviour of ships at sea and high-powered ship propulsion) and mathematics.

Students who complete the course satisfactorily will be awarded the Diploma in Advanced Engineering (D.A.E.).

Further information and forms of application may be obtained from the Warden, THE COLLEGE of AERONAUTICS, CRANFIELD, BLETCHLEY, BUCKS. B 278

THE COLLEGE OF AERONAUTICS

ONE YEAR POST-GRADUATE COURSE IN THE PHYSICS AND MECHANICS OF STRUCTURAL MATERIALS 1960-1961

Applications are invited for the one year course which begins on 10th October, 1960. Prospective students must be of graduate status in an appropriate branch of science or engineering and must have practical experience in one of the fields covered by the course.

The purpose of the course is to give instruction in the analytical methods of the theories of elasticity and plasticity and in the basic theories of the nature of materials derived from the sciences of physics, chemistry and metallurgy.

Students who complete the course satisfactorily will be awarded the Diploma in Advanced Engineering (D.A.E.).

Further information and forms of application may be obtained from: THE WARDEN, THE COLLEGE OF AERONAUTICS, CRANFIELD, BLETCHLEY, BUCKS. B 279

YORKSHIRE OUSE RIVER BOARD

ENGINEER'S DEPARTMENT

Applications are invited for the post of an ASSISTANT MECHANICAL ENGINEER on the Chief Engineer's staff. Applicants should have passed the examinations of the Institution of Mechanical Engineers and have had some experience of the operation and maintenance of excavators, tractors, vehicles and other items of contractor's plant. The salary will be in accordance with APT. Grades III-IV of the National Joint Council for Local Authorities' Services—£880-£1220.

Conditions of Appointment and Form of Application may be obtained from THE ENGINEER, YORKSHIRE OUSE RIVER BOARD, 21, PARK SQUARE SOUTH, LEEDS 1.

E. W. WELLS, B.Sc., M.I.C.E.,
Engineer to the Board. B 551

UNIVERSITY OF CAMBRIDGE

ESSO STUDENTSHIPS IN CHEMICAL ENGINEERING

The Managers of the Esso Fund invite applications for TWO ESSO STUDENTSHIPS. Applicants must be persons resident in Great Britain or Northern Ireland and should hold or expect to hold a University degree with high honours in chemical engineering or in some other branch of engineering or in pure science. The Studentships will be tenable for two years from 1 October, 1960. The Managers may renew a Studentship for a further tenure not exceeding one year. It will be the duty of the students to devote themselves to full-time study and training for research in chemical engineering. The value of the Studentships will be £400 a year plus fees.

Application forms may be obtained from the SECRETARY, DEPARTMENT OF CHEMICAL ENGINEERING, PEMBROKE STREET, CAMBRIDGE, and should be completed and returned by 30 April, 1960. B 550

CITY OF NOTTINGHAM

WATER DEPARTMENT

APPOINTMENT OF TWO CIVIL ENGINEERING ASSISTANTS

Applications for the above permanent, pensionable appointments are invited from Engineering Graduates and/or Corporate members of the Institution of Civil Engineers with at least five years satisfactory experience. Salary dependent upon qualifications and experience, in Grade APT. IV, viz., £1065 by £55 by £50's (2) to £1,220.

Applications, with names of two persons to whom reference may be made, to ENGINEER AND GENERAL MANAGER, WATER DEPARTMENT, CASTLE BOULEVARD, NOTTINGHAM, not later than 28th March, 1960.

T. J. OWEN,
Town Clerk.

THE GUILDHALL,
NOTTINGHAM. B 555

NORTH RIDING EDUCATION COMMITTEE

SCARBOROUGH TECHNICAL COLLEGE

Applications are invited for the following posts to take effect from September 1st, 1960:—

(1) ASSISTANT GRADE B for Electrical Installation Courses. Ability to teach elementary Radio an advantage.
(2) ASSISTANT GRADE B for Machine Shop Engineering and Mechanical Craft Practice Courses.

Forms and particulars available from me on receipt of stamped addressed envelope. Completed forms to be returned by March 25th, 1960.

F. BARRACLOUGH.

COUNTY HALL,
NORTHALLERTON. B 553

LONDON COUNTY COUNCIL

WANDSWORTH TECHNICAL COLLEGE require ASSISTANT, GRADE B, to teach Mechanical Engineering subjects to O.N.C. standard. Graduate or equivalent qualifications, industrial and teaching experience desirable. Burnham Salary Scale £700 by £27 10s. to £1150 plus London allowance and additions for training and qualifications. Increments within scale for experience.—Application forms from SECRETARY AT COLLEGE, WANDSWORTH HIGH STREET, S.W.18, returnable by 23 March, 1960. (486). B 557

ROYAL TECHNICAL COLLEGE, SALFORD

DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the appointment of a RESEARCH FELLOW in this COLLEGE OF ADVANCED TECHNOLOGY at a salary of £800-£850 per annum.

The person appointed will devote his whole time, for a minimum period of two years, to research in vibration phenomena in machine tools, for which there are excellent facilities and equipment. Applicants should have good academic qualifications and research experience in mechanical vibrations or in a closely related subject. The research is supported initially for two years by a D.S.I.R. grant, but candidates will be considered from the outset for appointment to the permanent academic staff of the College. If so appointed, the successful candidate would be expected to continue the research after the initial period of two years.

Further particulars and forms of application may be obtained from the REGISTRAR, ROYAL TECHNICAL COLLEGE, SALFORD 5, LANCS, to whom applications should be returned by Monday, 4th April, 1960.

R. RIBBLESDALE THORNTON,
Clerk to the Governors. B 556

DRAUGHTSMAN

DRAUGHTSMAN required by NORTH THAMES GAS BOARD at MONCK STREET, WESTMINSTER, S.W.1, for the design and detailing of reinforced concrete structures and foundations associated with gas works.

Candidates should possess the Higher National Certificates as a minimum qualification, and the starting salary will be according to qualifications and experience.

The appointment will be of a permanent nature, and the successful candidate will be required to join the Board's staff contributory pension scheme.

Applications, stating age, qualifications and experience, should be sent within ten days of the appearance of this advertisement to the STAFF CONTROLLER, NORTH THAMES GAS BOARD, 30 KENSINGTON CHURCH STREET, W.8, quoting reference EG/767. B 552

APPOINTMENTS OPEN

DRAUGHTSMEN

DRAUGHTSMEN required for design and development work on pneumatic and electric portable power tools. Interesting work, progressive and permanent positions. N.W. London area. State age, experience and salary required to Head Designer, BOX B 452, Offices of ENGINEERING.

ENGINEERING DRAUGHTSMEN AND ENGINEERS

ALL GRADES OF ENGINEERING DRAUGHTSMEN AND ENGINEERS required immediately. High starting salary.—Please Phone AMB 8189. B 424

PRODUCTION ENGINEER

A PRODUCTION ENGINEER is required to join the Engineering Department of a large Integrated Steel Plant.

Initially he will work closely with a Management Consultant in the investigation of a number of productivity and maintenance problems.

Later he will be required to lead a small team of Productivity Engineers in providing a service to the Engineering Department.

Applicants should be aged between 28-35 years, and possess an Engineering Degree or equivalent qualification and have had several years experience as a Production Engineer.

A four-figure salary will be paid according to qualifications and experience.

Applications, in writing, giving full details of age, qualifications and experience, should be addressed to URWICK, ORR & PARTNERS, LTD., ST. PAUL'S HOUSE, ST. PAUL'S STREET, LEEDS, 1, quoting reference GM/1383 on the envelope.

B 535

SENIOR DRAUGHTSMAN

SENIOR DRAUGHTSMAN required by firm specialising in High Pressure Valves, Receiver and Compressor Design.—Apply to SECRETARY, SIEBE, GORMAN & CO., LTD., DAVIS ROAD, CHESSINGTON. B 525

TECHNICAL WRITER

TECHNICAL WRITER, over 25, required by a Company in West London for preparing instruction books and technical literature on a wide range of chemical treatment plant. Previous experience of Technical Writing is desirable but candidates who can prove they can write good English and have an Engineering or Chemical background will be considered.—Please write giving full details of career and present salary to: THE PERSONNEL OFFICER, BOX B 519, Offices of ENGINEERING.

POWER ENGINEER

THE BOWATER PAPER CORPORATION LTD., ENGINEERING DIVISION, require the services of a qualified POWER ENGINEER for technical duties in connection with Industrial Power Plant. The applicant should have practical experience in the operation of modern Boiler House and Turbine House equipment and the maintenance of High Pressure Plant. He should also be familiar with the calculations necessary for thermal cycle comparisons in connection with new projects. The qualifications required are Graduate or Corporate membership of the Institution of Mechanical Engineers or the Higher National Certificate in Engineering.—Applications giving full details of qualifications, previous experience and salary required should be addressed to THE CHIEF ENGINEER, THE BOWATER PAPER CORPORATION LIMITED, ENGINEERING DIVISION, NORTHFLEET, KENT. B 508

YOUNG ENGINEER

YOUNG ENGINEER required as Boiler Sales Representative for London office. Age about 30. Experience on Boilers and combustion equipment essential: adaptable, enthusiastic. Salary will reflect experience and knowledge, and there is a generous pension scheme.—Apply STAFF MANAGER, RUSTON & HORNSBY, LTD., WATERSIDE SOUTH, LINCOLN. B 543

REPRESENTATIVES

REPRESENTATIVES wanted for correspondence abroad, high earnings, written instructions.

Write: FORTUNA PUBLISHING CO., VIENNA 1/8, POSTFACH 40, AUSTRIA. G 824

TECHNICAL ASSISTANT

TECHNICAL ASSISTANT for Sales Office engaged in tendering and executing contracts for transmission line insulation. Qualifications: Higher National Certificate in either Electrical or Mechanical Engineering. Previous tendering experience and ability to handle correspondence desirable but not essential.—Applications should be addressed to the PERSONNEL OFFICER (STAFF), PILKINGTON BROTHERS LIMITED, ST. HELENS, LANCASHIRE. B 511

RESEARCH ASSISTANT

RESEARCH ASSISTANT required for laboratory in North London. The work will be varied and will include the construction of equipment and experimental work of a physical nature. Applicants should preferably hold a Higher National Certificate in Applied Physics or its equivalent, and have had at least two years laboratory experience, including practical work on mechanical and electronic equipment, and be capable of working with the minimum of supervision. Consideration will be given, however, to applicants without formal qualifications, but having the right experience. This is an interesting post in an expanding research organisation, and both salary and prospects of advancement will be attractive to the right person. Applications to:—

THE DIRECTOR,
FURNITURE DEVELOPMENT COUNCIL,
2-4, DALMENY AVENUE,
HOLLOWAY, LONDON, N.7 B 509

MECHANICAL ENGINEER

MECHANICAL ENGINEER required for the design of new projects. Age not less than 30. Preferably A.M.I.Mech.E., with some years' experience in the chemical (or allied) industry. Salary range about £1200-£1500 p.a., according to age and qualifications. The appointment is permanent and pensionable.—Applications should be addressed to the PERSONNEL MANAGER, A. BOAKE, ROBERTS & CO., LTD., CARPENTERS ROAD, LONDON, E.15. B 560

CIVIL ENGINEER

CIVIL ENGINEER required for the design of new projects. Preferably A.M.I.C.E. with experience in industrial building design. Salary range about £1200-£1500 p.a., according to age and qualifications. The appointment is permanent and pensionable.—Applications should be addressed to the PERSONNEL MANAGER, A. BOAKE, ROBERTS & CO., LTD., CARPENTERS ROAD, LONDON, E.15. B 561

MECHANICAL ENGINEERING FOREMAN

MECHANICAL ENGINEERING FOREMAN required by light engineering company situated in West London to be responsible for a small machine factory group consisting of machine shop, tin shop and Bakelite moulding shop. Preference will be given to applicants 28/40 years of age who have served an apprenticeship and are studying Production Engineering. Superannuation scheme.—Write giving full details of age, education, experience and state salary required to PERSONNEL MANAGER, BOX ME2091, A.K. ADVG., LTD., 212a SHAFTESBURY AVENUE, LONDON, W.C.2. B 554

ASSISTANT SITE ENGINEER

A young ASSISTANT SITE ENGINEER is required by engineering firm specialising in the design and erection of high pressure steam raising plant. Preferable age would be between 25 and 30. Commencing salary would depend on qualifications and experience and there are good prospects for advancement. An out-working allowance is paid when working on site.—Applicants should forward full details of their education and previous employment to BOX B 545, Offices of ENGINEERING.

TECHNICAL PUBLICATION

Applications invited for appointment of a suitably

QUALIFIED MAN

to manage production of a technical publication in London. The work involves planning an improved type of publication, obtaining and writing articles on such subjects as (*a*) the historical aspects of engineers and engineering achievements (*b*) recent engineering developments in selected fields, and (*c*) possible future trends of engineering science. Applicants with a university degree or Diploma in Mechanical Engineering, and membership of a Professional Engineering Institution will receive special consideration. Age range 35-45 years. Superannuation provision. Salary in accordance with qualifications and general personal qualities.

Application, with details of experience, to BOX B 523, Offices of ENGINEERING.

THE CALTEX ORGANISATION

require an

ELECTRICAL ENGINEER

for service both in London and overseas to perform electrical design work for oil refineries and associated facilities.

General requirements are:—

(*a*) Degree in Electrical Engineering.
(*b*) Post Graduate apprenticeship with a large electrical industrial organisation.
(*c*) A.M.I.E.E.

Candidates should also have had approximately four years' experience as a Design Engineer responsible for the electrical aspects of power generation, distribution and industrial utilisation on systems up to and including 11 kV.

Preferred age group 28-32 years. Commencing salary would be dependent upon qualifications and experience. For Foreign Service, additional living allowances are paid and free medical attention, air-conditioned accommodation provided plus an initial kit allowance and attractive Vacation and Benefit Plans.

Apply in writing, quoting "ETS" with full particulars of qualifications and experience to CALTEX SERVICES LTD., CALTEX HOUSE, KNIGHTSBRIDGE GREEN, LONDON, S.W.1. B 510

JIG AND TOOL DRAUGHTSMAN

required

Previous experience in Machine Shop Tooling and design of Aircraft Assembly Jigs necessary, technical education to O.N.C. standard desirable.

Contributory Staff Pension and Life Assurance Scheme.

Applications, giving full details of qualifications, experience, age and salary required, and quoting Ref. H.A.L./111/ENG., should be forwarded to:—

THE PERSONNEL MANAGER,
HUNTING AIRCRAFT LTD.,
LUTON AIRPORT,
BEDS. B 505

DRAUGHTSMEN/DESIGNERS

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LIMITED

have vacancies for

MECHANICAL AND STRUCTURAL ENGINEERING DRAUGHTSMEN, required for design, layout and detail work on Steelworks Plant and Industrial Furnaces. Attractive salaries offered to men possessing ability and initiative. Contributory Pension Scheme. Five-day week. Holiday arrangements for this year can be mutually agreed.

Application, in confidence, giving details of education, training and experience, should be forwarded to:—

GENERAL MANAGER
FURNACE DIVISION
THE WELLMAN SMITH OWEN
ENGINEERING CORPORATION LTD.
WILTON ROAD
LONDON, S.W.1 B 548

THE CHESTERFIELD TUBE COMPANY LIMITED

makers of Steel Gas Cylinders, Hot and Cold Drawn Tubes, Extruded Tubes and Sections are creating the post of

SENIOR METHODS ENGINEER

Applicants should be in the age group 28-40, and should have at least H.N.C. or equivalent qualifications. Experience of modern Production Engineering methods, payment by results systems and Production Control techniques is essential. This post will carry considerable responsibility and offers good scope for a man with energy and initiative. It will carry with it the benefits of a contributory pensions scheme and a five-day week.

Applications, giving full details of Education, Experience and Salary required, should be addressed to

THE SECRETARY,
THE CHESTERFIELD TUBE
COMPANY LIMITED,
CHESTERFIELD B 470

JOHN LAING & SON LIMITED

require an

ASSISTANT MECHANICAL or ELECTRICAL ENGINEER

in the Design Office at their Headquarters.

Applicants should be Associate Members or Graduates of their appropriate institution and have design experience in Mechanical and Electrical Services to buildings.

The post is permanent and progressive. Five-day week. Superannuation scheme. Apply stating age, qualifications and experience to PERSONNEL MANAGER (M.E.S.4), JOHN LAING & SON, LIMITED, PAGE STREET, LONDON, N.W.7. B 462

DESIGN ENGINEER

A vacancy occurs in the Mechanical Design Section of the Process Plants Division of FOSTER WHEELER LTD. The work involves the mechanical design of Heat Exchangers, Pressure Vessels, Process Piping (including thermal analysis), and the various special problems which arise in the design of Oil Refinery and Chemical Plant. Preference given to a Graduate Engineer having a minimum of two years industrial experience, versatile, and with an aptitude for design. The position provides a wide range of interest, with full scope for original work in an integrated group. Salary will be commensurate with qualifications and experience. Pension and Life Assurance Scheme.

Write fully age, qualifications and experience, to:—

FOSTER WHEELER LTD.
3, IXWORTH PLACE,
LONDON, S.W.3 B 532

AEI

Qualified

FACTORY SERVICES ENGINEER

for service in India.

Applicants must have a wide knowledge and experience of the works services, and service equipment appropriate to large engineering factories, e.g. compressed air—steam—oxygen, acetylene, dust and fume extraction, ventilation, air conditioning, etc. A comprehensive knowledge of modern practices in safety precautions, safe methods of operation, and factory act requirements would be advantageous.

The ability to write tight and clear specifications for plant and services, and to examine and report on tenders is essential and also to supervise erection, make clear progress reports and check unacceptable work.

Three year contract in the first instance. Salary up to £2400, free housing and services, free medical attention, use of car, first class passages each way for engineer and family, and other valuable advantages.

Apply stating age, technical qualifications, experience, family circumstances and names of references to:—

SECRETARY, A.E.I. OVERSEAS LIMITED
33 Grosvenor Place · London, S.W.1.

B 528

AAEC

Careers in

NUCLEAR RESEARCH

THE AUSTRALIAN ATOMIC ENERGY COMMISSION has vacancies at its Research Establishment at Lucas Heights, Sydney, for:—

		Commencing Salary Ranges:
CHEMICAL ENGINEERS	Research & Development Process Design Chemical Plant Design	RESEARCH OFFICER: £A1510-£A2265 SENIOR RESEARCH OFFICER: £A2395-£A2720 Opportunities exist for advancement to PRINCIPAL RESEARCH OFFICER: £A2980-£A3500 and higher Qualifications for Research Officer posts—Honours Degree
CHEMISTS	Isotope Research Fuel Development Fuel Processing Spectrometry Analytical Chemistry Industrial Chemistry	
ENGINEERS	Reactor Calculations Theoretical Research Power Studies Experimental Research Electronic Engineering Design Engineering	
METALLURGISTS	Physical Metallurgy Mechanical Metallurgy	EXPERIMENTAL OFFICER I-III: £A1070-£A2330 SENIOR EXPERIMENTAL OFFICER: £A2460-£A2720 Qualifications for Experimental Officer posts—Pass Degree, Diploma or equivalent Commencing salary depends upon qualifications and experience
MATHEMATICIANS	Nuclear Physics Reactor Theory Digital Computing	
PHYSICISTS	Isotopes Research Reactor Physics Theoretical Research Experimental Research General Physics Radiation Detection Radiation Dosimetry	

If you would like to have further information and details of existing vacancies, the conditions of employment and application forms, write to:—

The A.A.E.C. Liaison Officer (Reference AAEC/1), Australia House, Strand, London, W.C.2

B 539

A National Electrical Service
Northern Electric
COMPANY LIMITED

NORTHERN ELECTRIC CO.—CANADA

OFFERS

JOB SECURITY TO MACHINE, TOOL AND GAUGE DESIGNERS

Experienced design personnel are required for high class, complex, tool and machine design assignments together with die and fixture design as required for the production of a complete range of telecommunications and wire and cable products.

These positions are located in the Montreal area. The Company, established in 1895, has recruited technical personnel in the United Kingdom for more than seven years. In the last 20 years no technical personnel have been laid off because of recessions.

Senior design personnel with appropriate training and experience will be interviewed in Great Britain during late March. Transportation allowance for successful applicants.

Give full details in first letter to:—

Dept. N.E.C.,
National Employment Service—Canada,
61 Green Street, London, W.1.

B 503

'Engineering' Appointments Section

ADVERTISEMENT RATES

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates:	per page (12 in. by 9 in.)	£100
	half page	£54
	quarter page	£29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates:	per page (12 in. by 9 in.)	£100
	per half page	£54
	quarter page	£29
	per single column inch	£2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line .. .. 4s. 6d.
(Minimum charge 18s.)

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26.

BOX NUMBER: 2s.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Companies

Rockets and Clothes Driers

SAVAGE AND PARSONS Limited are undertaking a two stage expansion programme. In the first phase 30,000 sq. ft of working area will be added to the existing works on land beside the present plant. The new building will be of two-bay single-storey construction. In the second stage a new fully air-conditioned office block will be erected.

At present about 25 per cent of the company's business is in the nuclear field, with handling equipment for radioactive materials making up the bulk. The balance consists of jobbing for the United Kingdom Atomic Energy Authority.

With KELVINATOR, S & P have developed low temperature test cells for aircraft and rocket research. The cells can operate at −75° C at a substantial vacuum to simulate stratospheric conditions. The cells are produced at the rate of one a month. For the Admiralty, S & P are making radar turning gear, which is installed "in the majority of new Navy ships." There are two on the shop floor at present.

S & P also have a financial interest in INFERATION (HOLDINGS) LTD. who have developed carbon filament resistance heaters for aircraft heating appliances. Savage and Parsons are using the same heater elements in a skirting heater and some clothes dryers for wall mounting.

Success in Diversification

From nuclear engineering, through NUCLEAR CHEMICAL PLANT Limited, to the headway made by the "youthful subsidiary," the POWER-GAS ERECTION Company, the fast expanding POWER-GAS CORPORATION is reaping the benefit of its vigorously conducted diversification policy.

The iron and steel industry is the corporation's largest post-war customer but it also has important connections with the chemical, gas and petrol industries and other interests elsewhere.

The upsurge in Power-Gas activities is sharply shown by the changed rate of orders. In the year which ended with 30 September, 1959, orders amounted to £7,750,000. In the first four months of the current year orders came in worth £9,300,000.

In his annual statement the chairman of Power-Gas, Mr. W. R. Brown, accounts for this by the removal of uncertainties by the election result in Britain and by the upswing in international trade.

Company by company, Mr. Brown ticks off ammonium sulphate plants in Germany and Italy, high pressure oil gasification plant in Belgium, high purity oxygen equipment in Germany and sulphuric acid production plant in the United Kingdom as part of the work of PG ENGINEERING Limited.

ASHMORE, BENSON, PEASE and Company are busy with the manufacture of heat exchangers, but in this industry as a whole capacity exceeds demand and competitive conditions do not permit profitable operations. Three blast furnaces were ordered from the company during the year and two of them have already broken records. Ashmore, Benson, Pease secured the only order of the year in the United Kingdom for a large furnace installation.

The ROSE, DOWNS & THOMPSON subsidiary now finds extensive credit terms needed to attract the bigger foreign orders. New markets opened up include the United States, Canada, Russia and Bulgaria.

The African company, ASHMORE, BENSON, PEASE & COMPANY AFRICA (PTY) continues to work on a blast furnace and an ammonia plant. The Power-Gas Erection Company has installed mechanical handling equipment as agents for specialist firms in the United Kingdom. A new branch office has been opened in Salisbury, Southern Rhodesia.

The rise in the profit (before depreciation and interest) of the corporation is a very steep line on the graph. In 1950 the figure was £402,846 and for 1959 £1,857,713 (almost 40 per cent more than the year before).

The chairman had no statement to make in his review on merger talks with Davy-United.

Vauxhall Take Bedfords to Liverpool

VAUXHALL, like FORD, the BRITISH MOTOR CORPORATION, and STANDARD-TRIUMPH, is to build a new factory near Liverpool. £30 million will be spent on the first phase of a great investment programme in which all production of Bedford trucks and commercial vehicles will be transferred to the south bank of the Mersey at Ellesmere Port. Space vacated at Dunstable and Luton will be used for increased output of Vauxhall cars.

The first phase is the press shop and installation for body assembly, painting trim and the final assembly of vehicles at Ellesmere Port. This should be completed in two years at a cost of £30 million and will employ 3,500 workers. Production of Vauxhall and Bedford should thus be increased by 100,000 units a year.

Next additional buildings will be constructed where production of engines, gearboxes, and axles will be transferred from Dunstable, thus creating an integrated factory at Ellesmere Port for complete production of Bedford vehicles. At the same time a new small press shop will be provided at Dunstable where offices and stores will also be extended.

At Luton new buildings will be provided for social and medical services, and a canteen, and eventually a new design and research headquarters will house all styling and engineering activities. At present Vauxhall and Bedford employ 26,800 people at Luton, Dunstable, and the surrounding district. The new factory on the Mersey will take the total employed in Britain to 34,000.

Prosperity

For Liverpool and district a new era of prosperity is beginning, but already Ford directors are becoming worried about competition for the available labour. This could inflate wages as it has done in Coventry.

There are others in the industry who regret that the British motor industry should be obliged to choose its new factory sites for social and political reasons, while competitors in other countries can locate their factories solely on consideration of efficiency.

Lancashire Steel Plans

The immediate building of a third open-hearth furnace and the installation of an electric furnace subject to permission, are among the development plans of the LANCASHIRE STEEL CORPORATION Limited.

A swing from a meagre order position late in 1958 and early in 1959 to not being able to fulfill all the orders at the end of the financial year is the story told in the company's annual statement.

Sir John James (inset), the chairman, declares in his statement that not in all his experience has the rod and wire trade, which suffers a certain amount from sudden swings, known such a rapid and complete reversal. The shortage appears to be world wide. Sir John reports that it is not possible to supplement home supplies from overseas either at reasonable prices or with practicable delivery dates.

The steel production of Lancashire Steel showed much the same pattern. Starting poorly it still finished with a record tonnage for the year and with the last quarter's output running at a substantially higher rate.

Accordingly a new rod and bar mill is to be built as soon as possible at the Lancashire Steel's Irlam works. This should be in production by the spring or early summer of next year.

One of those small developments that is more important than it sounds has occurred in the packaging section. A new nail packaging plant has been installed which has done away with bags and packs into cartons instead. This is particularly appreciated by customers abroad.

Overseas the interests of Lancashire Steel in other companies is principally in their subsidiary, LANCASHIRE STEEL (RHODESIA) (PRIVATE) Limited. The world wide shortage of rods has considerably affected the company. When steel is available from developments at the RHODESIAN IRON AND STEEL Company, in which Lancashire Steel have capital, and when the subsidiary's own rod mill now being installed is in production, this position should be corrected. It is then expected that Lancashire Steel (Rhodesia) should be able to meet the Federation's needs for wire, for many wire products, and still to be able to export.

Having now almost completed the 1953-58 programme, the company looks ahead to its 1960-65 plans. The aim is to increase ingot production to 800,000-900,000 tons a year.

One of the assumptions of these plans is that for the foreseeable future scrap will continue to be hard to come by due to the planned steel output increase. This has led to the proposal to build a further ore preparation plant, including a sinter plant, at Irlam, and a third large capacity blast furnace.

Only constant modernisation, says the chairman, increasing efficiency, and lowering of costs will enable the steel industry to compete with overseas producers having new works and the advantage of cheaper labour and raw materials.

Strong New Merger in Private Air Transport

Two of the largest private air operators in Britain are merging their air transport interests. They are the AIRWORK GROUP and HUNTING-CLAN AIR TRANSPORT.

The final outcome of the link up will be the biggest private operating firm in the United Kingdom, incorporating from the Airwork side, such historic names in the air world as MORTON and OLLEY AIR SERVICES.

Behind both groups are well known shipping firms. Hunting-Clan Air Holdings is 50 per cent owned by BRITISH AND COMMONWEALTH SHIPPING and FURNESS WITHY owns a third of the capital of Airwork, as does BLUE STAR LINE.

While the amalgamation will strengthen the hand of the new independent concern in the immensely costly business of replacing with the new big jets their existing fleets of Britannias, Viscounts, and DC3's, it may be of much greater significance in influencing the yet to be announced decision on the aspirations of the "independents" to run very cheap flights over the "cabotage" routes between Britain and the overseas dependencies. Routes within the Commonwealth are capable of being determined, as to the level of fares, by the British air operators without reference to the International Air Transport Association.

Both the helicopter activities of Airwork (FISON-AIRWORK and BRISTOW HELICOPTERS) and the aerial survey interests of Hunting are being kept clear of the merger, which is purely of air transport activities.

Menace to Paper Firms of Outer Seven

The paper manufacturing and handling companies of the United Kingdom have looked forward with more apprehension than almost any others to the future trading position in the European Free Trade Area,

Mr. Charles Snelling, the INVERESK PAPER Company chairman, describes in his annual statement how the immediate prospects and activity of his firm are favourable. But he goes on to say that EFTA in its present form is "a very grave menace to the paper-making industry in this country."

Being as close as they are to the source of supply for their wood pulp, it may be that the Scandinavian mills have an irreversible advantage. Mr. Snelling puts it like this when he says that costs in Britain are inflated by processes of which the Scandinavian integrated pulp and paper mills have no need.

He is not alone in his belief that if the two European trading groups were brought together the position would be less serious but this would not remove the economic advantages of mills so close to the Scandinavian forests.

Sampling with the Sequential Method

A machine has been developed which makes the application of the sequential method of sampling inspection a simple matter.

By W. R. Hindle,

Operational Research Engineer, English Electric Company Limited

The basic concept of sampling is easily understood. Few people would question the action of a chef when he tastes the soup. His expression of approval, or disapproval, coupled with the implication that his decision relates to the batch as a whole, is accepted without qualm. Common sense alone allows us to accept the assumption that the whole of the soup will have a similar taste to the sample. If we were to give a little further consideration to the chef's action, we would realise that he has no alternative to basing his decision on the information he gleans from his sample. The only inspection test open to him is a destructive one.

The validity of the action of an inspector in industry when he takes a few piece parts, examines them, and then pronounces judgment on the "lot" or "batch" is not so readily acceptable. We would be surprised, rather than otherwise, if a second sample gave very closely similar results. We are well aware of the fact that the inspector has an alternative, unless, of course, his test happens to be a destructive one; he could inspect every item and aim at eliminating all defectives. It is, perhaps, worthwhile to note that an examination of all items does not necessarily ensure that all defectives will be found.

Inspectors are human. We may not always be very ready to admit it, but perfection, in all fields of human activity, is an unattainable goal. We would not question the fact that the inspector's examination of a sample would give him some information about the batch, but a difficulty arises when we try to assess the value of the information on a quantitative basis.

The following passage is quoted from Mr. J. Moroney's book *Facts from Figures* (Penguin Press, London). "Britain has a proud record in the development of statistics. Yet already a rather familiar story is being retold. Other countries, notably the United States, are more alive to the practical value of these techniques."

There is a lot of evidence available to vouch for the truth of Mr. Moroney's statement and it follows that all technicians in this country, who may be concerned with the introduction of the relevant techniques, must be inspired somehow to expend greater effort in a bid to catch up with the leaders in this field. The economic advantages can be very considerable.

The question of how much knowledge, about a population as a whole, can be got from the detailed examination of a sample, is one which has claimed much attention from mathematicians. Other statistical theories closely related to the sampling one, have also been developed and, as a result, there is now available a variety of sampling inspection schemes which lay down specific courses of action. When properly used, these schemes ensure that the average quality, in batches of components after inspection, is at a level which is acceptable to both producer and consumer. In view of this, it is rather surprising to find that it is still quite a common practice for an arbitrary part of the batch (often 10 per cent) to be taken as a sample. An assumption is then made that an examination of this sample will yield as much information as is required about the lot. In the light of present day knowledge this can be seen to be a haphazard approach to what is really a very complex problem.

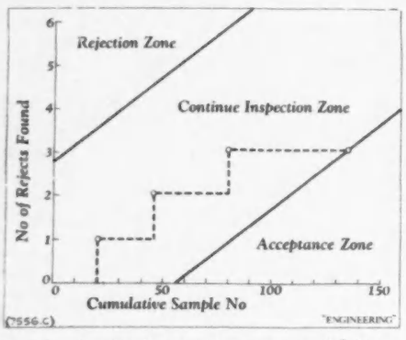


Fig. 2 A rejection-acceptance sequential inspection plan illustrated graphically.

It is important to note that though the basic theories, underlying inspection sampling plans, are the result of study by theoretical statisticians, in general, the actual plans have been developed by more practical men.

Since one of the primary reasons for considering the adoption of a sampling inspection technique is an economic one, it is logical to consider the sequential method; because, to achieve a required standard of outgoing quality, this technique is generally more economic than any other. Very often the desired level of protection, both for the producer and consumer, can be achieved sequentially, with a much lower inspection density than is necessary when the better known single and double sampling inspection plans are used.* In some cases the average number we need to inspect, to give us the desired scheme characteristics, is reduced by 50 per cent.

It must not be assumed that this new technique completely supersedes all other sampling methods. There are situations where the single sampling plans, which demand the highest inspection density of all the types, for a given level of protection, are still the best to use. On the other hand, a decision to use the sequential method, or even to change over to it, can very often result in economies which, as previously stated, can be very considerable.

Sequential Analysis of Statistical Data, published by Columbia University Press, New York, outlines the method of design of sequential plans for acceptance—rejection inspection, and also includes details of the design of sequential plans for other purposes which have no relevance to this article. The following is quoted from this publication: "Its value in enabling reliable conclusions to be wrung from a minimum of data was deemed sufficient to require that it be classified restricted within the meaning of the Espionage Act. The Army, the Navy and the Office of Scientific Research and Development, however, introduced it into several thousand manufacturing establishments as a basis for acceptance inspection and this resulted in a widespread demand for access to information on the subject. In response to representations from the War Production Board, the Army and the Navy, the restricted classification was removed in May, 1945. There can be no further need to emphasise the value of such techniques in industry both in relation to process inspection and to research."

It is important to understand that when, in what follows, we speak of acceptance-rejection, acceptance means acceptance of a lot on the evidence of a sample and rejection means rejection of a lot to be sent back for 100 per cent inspection on the evidence of a sample. Only in the rare case where inspection costs are higher than rework costs would rejection mean rejecting the batch as scrap.

In common with other statistically based inspection schemes sequential sampling is designed to give a desired level of protection to both producer and consumer. Thus, it is always necessary to decide appropriate values for the four following attributes.

* H. F. Dodge and H. G. Romig, *Sampling Inspection Tables*. (Chapman and Hall.)

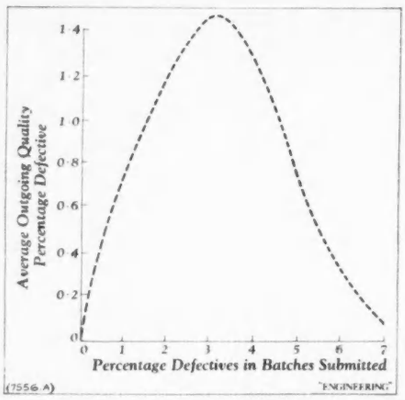


Fig. 1 The average outgoing quality is a function of the percentage defectives in the batches submitted.

(1) Acceptable quality, expressed as fraction defective. It may be decided, for instance, that a batch will be considered as of acceptable quality if it contains 1 per cent or less of defectives.

(2) The probability of rejecting for 100 per cent inspection a batch of acceptable quality. This means that a risk will have to be taken that a small percentage of batches, which are in fact of acceptable quality, will be rejected for 100 per cent inspection.

(3) Unacceptable quality, expressed as fraction defective. A batch containing say 3 per cent or more defectives may be considered as of unacceptable quality.

(4) The probability of accepting a batch of unacceptable quality. Again a risk will have to be taken that a small percentage of batches of unacceptable quality will in fact be accepted by the scheme.

When a sequential plan has been designed and is put into operation on a number of batches, the average outgoing quality will be a function of the percentage defectives in the batches submitted for inspection. This is illustrated in graph form in Fig. 1.

Note that the outgoing percentage defectives, that is the percentage of defectives remaining in the batches after inspection, reaches a peak value. In the case of the plan illustrated in Fig. 1, the peak occurs when there are approximately 3 per cent defective items in the batches being submitted for inspection. The peak can, of course, be set at any desired point and is one of the design characteristics of a specific scheme.

Referring to the graph and starting from the

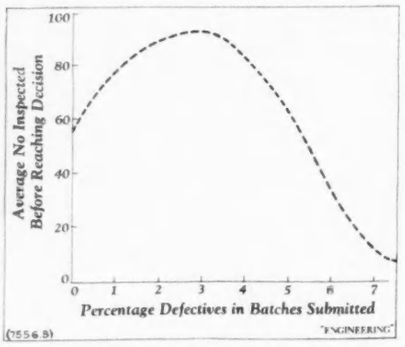


Fig. 3 The average number of components which will be inspected before a decision is made shown as a function of the defectives in the batch.

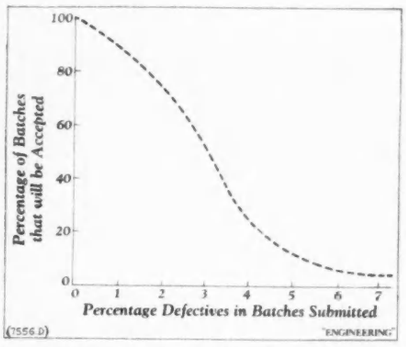


Fig. 4 The percentage of batches which will be accepted varies with the percentage of defectives.

origin, as the percentage of defectives in the batches submitted rises, the average outgoing quality percent defectives also rises. If, however, the quality being submitted deteriorates to a point where more than 3 per cent defectives are in the batches submitted (that is, we pass the critical point of the curve) an automatic increase in inspection density will begin to operate, and the average outgoing quality will improve.

There are four main types of sampling inspection scheme: single sampling, double sampling, multiple sampling, and sequential sampling. The plans are designed in all cases to ensure that the inherent risks of reaching wrong decisions are held within certain predetermined acceptable levels. These risks are well known as the "producer" and "consumer" risks and are, respectively: the risk of rejecting a batch (for 100 per cent inspection) when it is in fact of acceptable quality, and the risk of accepting a batch when it is in fact of unacceptable quality.

For the same levels of risk, the total inspection density required by these schemes is progressively less in the order in which they are named above. Thus, single sampling calls for the highest inspection density and sequential sampling calls for the least.

There is one significant difference between the sequential method and all the others, the first three lay down fixed sample sizes but in sequential sampling the size of the sample is not predetermined. The procedure adopted is to inspect components in the usual way and cumulatively to consider the evidence available for making a decision. At any stage in the inspection the evidence (and the degree of risk adopted) will lead to one of three possible actions. This will be to accept the lot, to reject the lot for 100 per cent inspection, or to continue inspection.

The last decision, to continue inspection, is made when there is insufficient evidence to allow either of the others to be made. A rejection-acceptance sequential inspection plan is illustrated in Fig. 2. Referring to Fig. 2, it will be apparent that the inspection of a component results in a shift of the operative chart position one unit along the horizontal axis, and, if the component is a reject, the operative chart position also shifts one unit parallel to the vertical axis. As previously mentioned, each change of operative position on the chart will lead to one of three possible results: violation of the rejection line, violation of the acceptance line, or violation of neither line, which indicates "continue inspection."

In order to clarify the above fully, a hypothetical situation has been plotted in Fig. 2. Component No. 20 was a reject and since this was the first reject found, the operative position was moved vertically one unit from the horizontal axis. This point is in the "continue testing" zone, so inspection was continued. Components continued to be acceptable until No. 45 which was again a reject, and as a result the operative position was moved another vertical unit, and similarly at component No. 80. Subsequent components were again acceptable and the acceptance line was crossed at component No. 138. The indicated decision "accept the batch" was accordingly taken.

We have seen that a sequential plan is not based on a fixed sample size. It should be clear that the average number of components that it will be necessary to inspect, will vary with the percentage of defective items present in the batches submitted to the inspector. It is possible to calculate, for any specific plan, these average sample numbers, and also to determine the percentage of batches that will be rejected for 100 per cent screening. The figures quoted in what follows refer to the sequential plan of Fig. 2 and the related design graphs of Figs. 1, 3 and 4 but the philosphy is common to any sequential plan.

Let us suppose that the lots being submitted to inspection contain 1 per cent of defectives; the graph of Fig. 3 tells us that a decision will be reached after an average of 72 components have been examined. The graph of Fig. 4 gives us the additional information that in over 90 per cent of cases the decision arrived at will be "accept the batch." In this case we see that, providing the stated conditions of average per cent defectives being submitted is maintained, we will have rather less than 10 per cent of batches to inspect 100 per cent in order to ensure that the percentage of defectives, remaining in the whole of the outgoing population, will be something less than the peak value of 1·5 per cent shown in Fig. 1.

We will now examine the position with a view to noting what happens if the production process deteriorates and batches are submitted which contain, say, 6 per cent defective items. Referring again to Fig. 3 we find that a decision will be reached, in these conditions, after an average of 30 components only have been examined. Fig. 4 tells us that we will now have to screen more than 90 per cent of the batches submitted. The total inspection density has clearly increased.

It should now be evident that the graphs of Figs. 3 and 4 enable a good estimate of inspection costs to be made, prior to the introduction of the scheme, providing production process data are available. The information needed is, of course, the average percentage of defectives likely to be in the batches submitted to inspection. A reasonably close estimate of the process average per cent defective is usually available. Even when this is not the case, it is rarely difficult to get the required data.

It has probably occurred to a number of people that it would be a very considerable step forward if a practical mechanical means of interpreting sequential plans could be devised. The author has, in fact, developed an apparatus which performs this function. Field trials of the machine have convincingly demonstrated its practicability and the English Electric Company Limited are considering its manufacture on a commercial basis, in addition to its manufacture within the group. Fig. 5 shows a prototype machine in use at the group's factory at Clayton-le-Moors.

The machine can be programmed to deal with sequential plans designed for a variety of different purposes. We are only concerned here with its use in connection with acceptance-rejection inspection, and what follows will be confined to the use of the apparatus for this purpose. After the machine has been programmed, with a sequential plan having the required characteristics, component inspection is started in the usual way. A push button on the machine is depressed manually each time a component dealt with satisfies the inspection standard. When an item fails to pass the gauges, or in some other way fails to comply with inspection requirements, a rotary switch is advanced one step. When certain values of "cumulative" count and "defectives" count coincide a signal light will flash on. If the signal light is red it indicates that the rejection line of the graph has been violated. The batch or lot will have to be screened 100 per cent. On the other hand, if the signal given is the green light, inspection can be terminated and the batch can be accepted.

Table.— Results from the application of the plan.

Component identity	Approx. No. in batch	Cumulative Sample No.	No. of rejects found	Decision
A	800	4	2	Reject
A	800	59	0	Pass
B	2,000	59	0	Pass
B	4,000	59	0	Pass
B	3,000	59	0	Pass
C	2,000	79	4	Reject
C	1,000	105	5	Reject
B	1,000	59	0	Pass
D	800	59	0	Pass
D	400	59	0	Pass
A	900	59	0	Pass
A	800	59	0	Pass

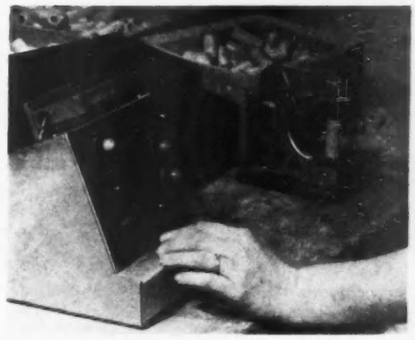


Fig. 5 A prototype machine in use at the English Electric factory at Clayton-le-Moors.

The counter totals standing on the machine at the time when a decision signal is seen are recorded in the manner shown in the Table. To return the machine to a starting position, in other words to ensure that the operating position is equivalent to being at the origin point of the sequential graph, it is necessary only to operate a push button. The counters will return to zero and an orange signal light will flash on, to indicate that the return to zero position has in fact been carried out.

The problem of quickly changing the scheme to which the machine has been programmed, has been dealt with. This operation can be carried out in a matter of seconds. Experience has shown that ordinary shop inspection personnel can operate this machine, and be completely at home with it, immediately it is introduced. All the onus of counting and making decisions has been taken over by the machine. The foreman inspector, or whoever it is who may be concerned with outgoing quality, can be reasonably sure that the sequential plan is being strictly followed, since the risk of counting errors has been reduced.

The following is a practical example from the writer's own experience. A sequential analysis inspection plan was designed to ensure a set minimum standard of outgoing quality for a "machined all over" brass component. The maximum outgoing percentage defectives was set at 1·5 per cent and the process average percentage defectives was known to be in the region of 2 per cent. Six batches of 400 components per batch were inspected to the plan. Three batches were accepted, and three batches were rejected for 100 per cent inspection. Six attributes were gauged, but all the rejects found had the same defect: a faulty internal thread. On the assumption that by the introduction of quality control, for the internal thread, it would be practicable to achieve the desired quality level, the following assessment of savings in inspection time was possible. Estimated inspection time, to control quality of internal thread at point of production, 34 minutes per 1,000. Estimated inspection time for sequential sampling on the assumption that at least 95 per cent of all the batches would be accepted, since the internal thread would now be at the desired quality level, 30 minutes per 1,000. The total inspection time would thus be 64 minutes per 1,000. The original inspection time, prior to the introduction of the sampling scheme was 330 minutes per 1,000 and therefore the estimated saving of time would be 80 per cent.

Acknowledgement.—The author wishes to acknowledge the English Electric Company Limited for permission to publish this article.

Testing Ores for Electric Smelting

Electric smelting has so many possibilities today that Birlec-Efco (Melting) Limited have erected a pilot plant for trial operation on materials submitted by prospective customers.

Electric smelting—as distinct from melting—is a well established process in certain fields; for some products it is accepted as the only economic method of production. Like electric melting, its use is spreading. Electric smelting can be defined, broadly, as an electro-thermal process for the extraction of metals from their ores, though it is also used for certain non-metallic substances as well. It has several advantages. It is clean, can be controlled very accurately, and promotes a high degree of metal recovery. In many of its applications it is possible to use low-cost carbonaceous materials instead of high-grade metallurgical coke as a reducing agent. Many smelting operations generate a gas of considerable value, and arrangements can be incorporated in the electric furnace, as in other furnaces, for collecting this gas so that it can be used elsewhere in the plant. All these operating advantages have, of course, been recognised and used for many years, but more recently a further influence has operated in favour of electric smelting furnaces. This is the relative cheapening of the unit cost of electricity compared with other sources of heat. Since fuel represents a very large proportion of the total cost of smelting, and electricity can be used as a fuel for this purpose, the economics of smelting are undergoing an important change. The capital cost of erecting a smelting installation, of whatever type, is bound to be considerable, and it is for this reason that Birlec-Efco (Melting) Limited have erected the trial plant at their works at Aldridge, Staffordshire.

Prospective users of the electric smelting process can send their raw materials for test smelting in the Aldridge plant, and for a fee agreed in advance Birlefco will carry out a full trial under scaled-down operating conditions. From the results of this trial, detailed information of the general suitability of the process for the materials in question is obtained. A record is kept of such factors as power and electrode consumption, operating voltage, percentage recovery and other details, and from this record it is possible to make a fairly accurate appraisal of what can be expected in large-scale production. At the end of the test, the finished product and balance of raw materials are returned to the customer, and Birlefco supply a detailed report giving recommendations on smelting practice, electrical ratings and size of installation required for a given output.

The furnace is installed in a special building, with an overhead electric travelling crane, and equipment for material crushing, ladle heating and casting into sand or metal moulds is provided. There is also a laboratory, and the plant is thus entirely self-contained and capable of carrying out tests as a complete unit.

With a nominal capacity of 350 kVA, the furnace is designed to be as versatile as possible. It has a shell 8 ft internal diameter and is charged from a platform 9 ft above the main floor level of the building. Furnace controls are mounted in a panel at charging floor level, and the transformer (supplied by BTH) is housed in an adjacent section of the building. To give electrical operating flexibility, the transformer has an ancillary cooler enabling high outputs to be obtained for special smelting applications, and it is arranged so that the secondary windings can be connected in series or parallel. With the series connection a voltage range of 250/130V in 20V steps is available, and with parallel connection the range is 125/65V in 10V steps. The electrodes, which are normally 8 in diameter, can be of amorphous carbon or graphite according to requirements; smaller electrodes can be fitted if necessary.

In addition to being electrically flexible, the furnace has several other features which make it suitable for operation in various ways to suit different materials. There are three tapholes at different heights in the shell, and varying quantities of metal and slag can be tapped. A monorail forming a complete loop round the shell carries hoist blocks from which slag pots or metal ladles can be suspended. Slag or metal can thus be collected at any of the tapholes and brought to the front of the furnace for disposal or casting. Several thermcouples are built into the refractory lining of the furnace shell to monitor the hearth and sidewall temperatures at different points. To determine the effect of shell rotation on different smelting operations, the shell can be either rotated continuously at various speeds, or it can be oscillated. The furnace can be operated with an open or closed top, and a very effective fume extraction plant is fitted. For experimental use, the extraction plant is connected to a cleaning plant which removes the harmful constituents and dust before discharging the fumes to atmosphere, but in a production installation the fumes could be withdrawn from the furnace and burnt or otherwise used in another part of the plant.

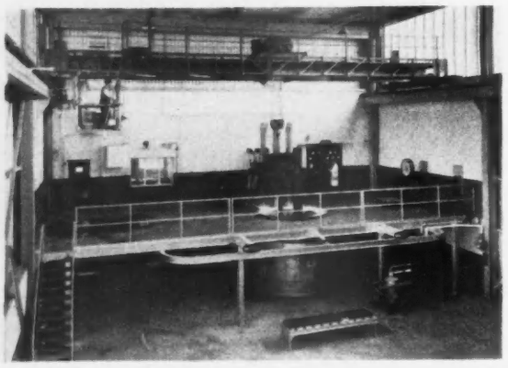
A process for which electric smelting is already widely used is calcium carbide production. Though it is not strictly speaking a smelting process in the generally accepted sense of the word, the furnace is particularly suitable for it. Calcium carbide is made by the reaction of calcium in the form of burnt lime, with carbon, which is supplied as coke or some other form. The electric furnace is the only practicable means at present of supplying the high temperature required. Production of phosphorus by reduction of the mineral apatite is another operation for which the electric smelting furnace is widely used. But electric smelting is also extending in new and relatively undeveloped fields as well, and here the Birlefco plant provides facilities for an assessment of the possibilities without the necessity for incurring capital expenditure on the part of the prospective user.

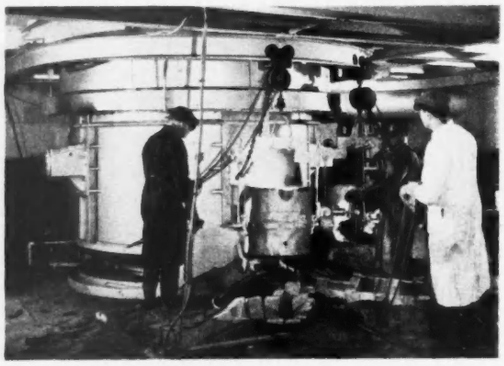
One field in which electric smelting is already widely applied and which is expanding is in the production of ferro-alloys, which are used extensively in the refining and alloying of steel. Certain grades of ferro-alloys can be and are made in the blast furnace, but the electric furnace offers many advantages for this type of work.

Ferro-silicon is a typical product of the electric smelting furnace; it was one of the first materials to be produced in the Birlefco pilot plant. It is produced from a charge consisting of silica rock, steel scrap and carbon. At Aldridge, the charge consisted of natural pebbles, steel punchings and charcoal in weighed quantities, fed into the furnace manually. For larger, permanent installations, mechanical feeding equipment is used. Different mechanical feeding equipment would be needed for different materials and the plant is intended to test electric smelting, not mechanical handling.

There are many other actual and possible applications of electric smelting. One which is practised in some parts of the world, but is as yet in its infancy, is the production of pig iron. The blast furnace is still the principal producer of pig iron, but depends upon supplies of high grade metallurgical coke, which is not everywhere in plentiful supply and in some regions is virtually unobtainable. In the electric smelting furnace no coke is needed as fuel, and the carbonaceous matter used as a reducing agent need not possess a high crushing strength. Consequently charcoal char made from lignite or non-caking coal, high-ash anthracite or coke breeze can be used according to local conditions.

Where supplies of carbonaceous materials and iron ore are available together with relatively cheap electric power, the economics of electric smelting may well be favourable to its adoption. Nor is this all. Some ores which are not suitable for the blast furnace, such as titaniferous ores, can be smelted by the electric furnace, which can also handle high-lime slags for the production of low-sulphur iron. Electric furnaces are not yet built in capacities to equal a modern blast furnace, but with ore beneficiation, which is becoming more widespread, the output capacity of a given size of furnace may easily be doubled. About 3 million tons of pig iron are produced annually by electric smelting throughout the world at present—an insignificant proportion of the total production, but the possibilities for expansion are great. The Birlefco installation at Aldridge will provide operating data on which the expansion of this application, and others, can be based.





(Left) Of 350 kVA rating, the Birlefco pilot smelting furnace is specially designed for trial operation on customers' materials.

(Right) Metal or slag can be tapped from any one of three tapholes, at different heights from the furnace hearth.

Helicopter Landing at Night

Battersea Heliport, London, was built by Westland Aircraft Limited to assist in the development of civil application of the helicopter, and particularly to stimulate its use in the London area. Although the heliport is neither large enough nor near enough to the city centre to become a permanent base, it has already, since its opening in April, 1959, attracted considerable traffic.

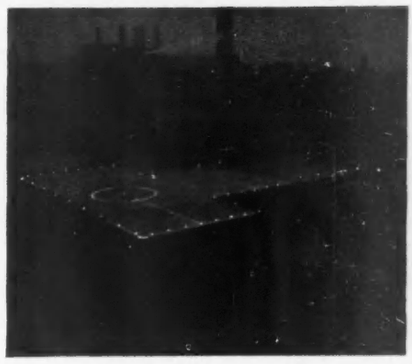
The average number of movements a month was about 150 during daylight hours only. To increase the heliport's capacity, night-flying facilities have been added, and a licence has now been granted for night operation.

Supplied by the General Electric Company Limited, the lighting consists of medium intensity elevated perimeter lights to show pilots the boundaries of the landing platform, and tower-mounted floodlights to make the platform stand out against its surroundings, particularly the River Thames. By giving texture to the concrete platform, the floodlights help pilots to judge their height on the final approach.

An angle of approach indicator gives assistance to pilots as they approach the heliport at a height of between 500 and 1,000 ft, following the Thames. This indicator gives a flashing signal divided horizontally into coloured zones. If the pilot is too high he sees an amber light, if too low a red one, and if he is on the correct approach path—which at Battersea is angled at 12° above the horizontal—a green light is visible.

A helicopter has to land among the approach lights, unlike a fixed-wing aircraft, which passes over them, and to prevent pilots being dazzled, the lights can be dimmed during the final stages of an approach.

Obstructions close to heliport are marked by red lights, and the corners of the landing platform, which juts into the river, are provided with navigation lights as a warning to shipping.



Pilot's-eye view of Battersea Heliport during a night landing approach.

Fuel by Pipeline

One of the features of the changing pattern of transport, which has received comparatively little attention in this country is the movement of fuel by pipeline. But it is expanding and must, in due course, have its effect on traditional methods of transport. Gas, of course, is the oldest example of a fuel transported and distributed by pipeline and it is envisaged that a considerable expansion in bulk movement of gas in pipelines will take place—in fact it is already being developed. Natural gas is transported over long distances by pipeline in the USA and parts of Europe, and it has been forecast that in this country manufactured gas will be made at the pithead and sent to the main consuming centres in a high pressure gas grid, instead of being made at the point of consumption from coal and oil transported by road, rail and sea. As gas grids develop and a nation-wide network is set up, the need for land transport of bottled gas to small consumers will be reduced as well. Large consumers of industrial gases such as oxygen already have their internal pipeline networks, fed either by their own gas production plants or in bulk by road or rail vehicles. This development can be extended to fuel gases as well.

Nor is gas the only fuel which can be transported by pipeline. In the USA a hydraulic pipeline transports 1,250,000 tons of coal a year 110 miles from the pithead to a power station. In this country, where the distances from pithead to large centres of consumption are often small, this development has considerable possibilities.

Coal transport by pipeline may be a matter for future development; transport of oil and oil products is already in hand. The practicability of moving large quantities of oil products over comparatively long distances by pipeline was amply demonstrated by war-time developments in this country. These included, as is well known, a pipeline across the English Channel. Pipeline transport of petrol is being applied to commercial distribution, and aviation fuel is now piped to London Airport.

Hitherto, aviation fuel has been delivered to London Airport by road tankers operating from Shell-Mex and BP storage centres at Purfleet and Shell Haven in the Thames estuary. Throughout the year a daily average of 40 tankers, the largest of 4,000 gallons capacity, made round trips of roughly 80 and 100 miles between the airport and storage points. At peak periods, 60 tankers a day were needed.

To start the scheme, fuel is being piped from bulk storage at Walton depot on the south side of the Thames to the airport over a distance of 9 miles in two 6 in diameter pipelines. Initial deliveries will be at a rate of 30,000 gall per hr.

The pipeline was laid, mainly in 40 ft lengths, by William Press and Sons Limited, Tottenham. All welded joints were radiographed as work proceeded. Corrosion protection is provided by a $\frac{1}{8}$ in thick coating, applied hot and reinforced by an inner and outer layer of glass fibre. The pipe wrapping was undertaken by Wailes Dove Bitumastic Limited, Hebburn-on-Tyne. In its nine-mile course the pipeline crosses 27 roads, two railway lines, two minor rivers as well as the Thames, and Kempton racecourse. Construction was planned to avoid interference with racing and with Thames regattas. Thrust boring took the pipeline under the railway without interference with traffic.

For the time being, fuel will be delivered to Walton by normal transport from the Shell-Mex and BP installation at Hamble, near Southampton, but later in the year it is planned to provide also for piping fuel to Walter from a Kent refinery, near the mouth of the Thames. For this purpose a 65-mile war-time pipeline owned by the Government is being renovated.

Already it is possible to deliver fuel at all seasons and without delay due to traffic congestion on the roads through London and near the airport. When the pipeline is completed, deliveries will be entirely independent of weather and traffic at all times.

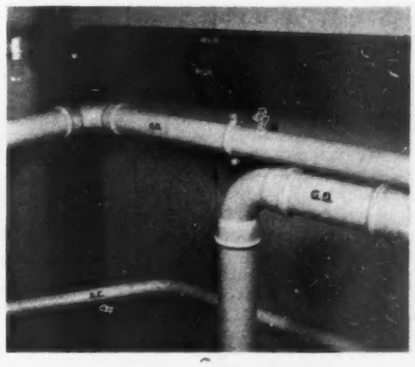
Pipelines Identified Cheaply

British Standard specification 1710:1951 gives a colour coding for the identification of the contents of pipelines, the colours being applied either by painting the whole of the pipeline, or by applying coloured bands at frequent intervals. This standard is widely applied and is of great value, especially where pipe runs are complicated. Its only disadvantages are in the time, materials and labour costs of painting the pipes—and the fact that some workers may be colour blind.

To simplify pipeline coding, Gordon and Gotch (Sellotape) Limited, 8-10 Paul Street, London, EC2, have made available a pipeline identification tape which can be applied in the form of rings as required. It is available in colours to BS1710, and in addition it can be supplied with an abbreviated letter code, or with the contents of the pipeline printed in full. This latter arrangement has obvious advantages where the works staff may not be fully acquainted with the letter or colour coding system.

Tests have shown that the tape is equally suitable for indoor or outdoor use. It has withstood severe winter conditions on exposed pipework, and it is highly resistant to dry heat or intense humidity. It is also resistant to chemical or steam-laden atmospheres, and to salt water. The bands can be applied in a matter of seconds, and when it is necessary to replace them—at intervals of about two years—the operation is equally simple. A further advantage is that no complicated access equipment is needed for the simple operation of applying bands in inaccessible positions; scaffolding would often be necessary if pipelines were being painted.

Sellotape pipeline identification has been put into operation by the English Steel Corporation Limited, Sheffield, by the UKAEA at Harwell, and by numerous other industrial concerns. In the case of English Steel, a central depot is being established at Sheffield, from which all the works in the group will draw their supplies of tape as required.



Pipelines, as this group at Harwell, are easily identified by these special bands.

On the Shelf

By Frank H. Smith

Is this merger business getting out of hand? I suppose the *Stock Exchange Yearbook* or some such publication keeps financiers abreast of the latest marriages but who is going to look after us poor souls who have to keep tabs on such alliances as that between the Royal Aeronautical Society and the Helicopter Association of Great Britain, and that other which is now in the air betwixt the Institution of Civil Engineers and the Institution of Municipal Engineers? There is room here for another specialist occupation: "membership grade reconciler." All the same, it is quite a pleasant game trying to think up other brackets, the Electricals with the Radio Engineers, the Aeronauticals with the Interplanetaries, the Mechanicals with the Productions, the Civils with the Structurals, and so on. It would bring out in the open much that has gone on in people's minds for a long time.

I believe one of the bones of contention in the book trade is the selling of discs (phonograph variety) by booksellers. Should they or should they not? Anyway, Collet's have no doubts about what their attitude is and they have their record shop at 70 New Oxford Street, London, WC1. In connection with this they have started a "direct disc service" by which they will keep customers advised of the latest arrivals from the States, China, USSR and Europe. They wish, it seems, to help the collector who, they point out, may already have three recordings of Beethoven's Fifth and does not want any more whether it be on plain or stereo. Send a postcard for full details of this "Liszt while I tell you" service.

British Scientific Instrument Research Association (wish I were not a campaigner against initials) of South Hill, Chislehurst, Kent, announce No. 3 in their series of surveys of instrument parts—*Torsion Devices* by P. J. Geary at 21*s*, or 23*s* 6*d* if you live in furrin parts. Mr. Geary seems to have a monopoly of this series as he also wrote the previous two—*Flexure Devices* at 10*s* 6*d* and *Knife-Edge Bearings* at the same price.

Camera fiends will know, I expect, of the new catalogue from Fountain Press (46-47 Chancery Lane, London, WC2).

The January 1960 number of *The Mining Electrical and Mechanical Engineer* (the organ of the Association of that name) celebrates 50 years with a jubilee number. The address is 28 Kennedy Street, Manchester 2, so maybe the Association is not so well-known down south as it should be. The articles are, perhaps inevitably, largely Look Back with Pleasure but they have managed to work in a rather jolly three-fold diagram of Calder Hall.

In the Max Parrish (55 Queen Anne Street, London, W1) spring list are one or two titles that bear mentioning here. *Residence and Technical Education*, by Dorothy Silbertson, at 16*s*, and *The Smaller Firm and Technical Education* at 18*s*. Before buying, I suggest you ask the publishers for the catalogue as this gives a summary of what the books are about and suggests one or two other titles you might like that I should not mention here.

Microcard Bulletin No. 20 for January advises the opening of the joint office of the Microcard Foundation and the Microcard Corporation (*you* work that one out) at 901, 26th Street NW, Washington 7, in the Foggy Bottom section of Washington. One hopes that the prints are not like the Bottom. I could write the whole column on the contents of the *Bulletin*—and it's only four pages—so get your own.

I have always been in two minds whether to use the expression "up to now" or "until now" but a handout I recently received from the Pillman Aircraft Company extolling the virtues of a forthcoming Bell helicopter solves the problem once and for all. It talks about "uptil now." Do I wish I could coin words. Yeah man!

Electrical Imagery

Analog Simulation. By WALTER J. KARPLUS. *McGraw-Hill* (77*s* 6*d*)

Dynamical Analogies. By HARRY F. OLSON. Second Edition. *D. Van Nostrand* (51*s*)

In the analogy between circuits and mechanisms, there are two ideas which appeal very strongly to the student. They are (*a*) that electromotive force is analogous to mechanical force, and current to mechanical motion; and (*b*) that connecting two points together with a low-resistance wire is analogous to joining two points with a rigid link or shaft. It is very unfortunate that these ideas are inconsistent with one another, and that (*a*) is usually retained, and (*b*) discarded.

Hypothesis (*b*) implies the converse of (*a*), that electromotive force is analogous to mechanical velocity, and current to mechanical force or torque. This is called the "mobility analogy" in America, and results in capacitance to earth for the analogue of mass or inertia, conductance for the analogue of viscous friction, and inductance for the analogue of spring compliance. (The last-mentioned fact is easily memorised by thinking of the usual curly symbol for an inductor; other mnemonics are *V*oltage-*V*elocity, and *C*urrent-*C*ouple.) Use of the mobility analogy means that the diagrams of the circuit and mechanism are topologically identical, so that it is easy to draw the equivalent circuit of a mechanism. If hypothesis (*a*), the so-called "direct analogy," is taken, then the diagrams of circuit and mechanism are topologically dual, and the passage from one to the other is devious and requires practice to perfect it.

The above argument should have been the central idea of Dr. Olson's book. In fact, he sticks firmly to the "direct analogy" all through, except for one short chapter on the mobility analogy added for the second edition. Even here he obscures the clarity of his material by poor diagrams, and by sometimes omitting the transformer which is the equivalent of a lever. At no point does he give any rules for drawing the equivalent circuit of a mechanism, and nowhere does he mention duality. Apart from these grave deficiencies, there are other faults. The physical basis of the equations is not adequately brought out, the treatment is superficial and repetitious, and the author does not comment on his results or express any opinions. The student will learn far more of the subject from the classic papers by A. Block ("Electromechanical Analogies and Their Use for the Analysis of Mechanical and Electrical Systems," *Journal I.E.E.*, 1945, vol. 92, part I, p. 157; and "On Methods for the Construction of Networks Dual to Non-Planar Networks," *Proc. Physical Society*, 1946, vol. 58, p. 677) than from *Dynamical Analogies*.

Dr. Karplus, whose main topic is the solution of field problems, also mentions both the analogies between circuits and mechanisms in his introduction. Although he does not point out the advantage of the mobility analogy, he does deal fairly with duality. His introduction compares analogue and digital computing in a sensible way, and explains the paramount importance of electrical analogies.

The first part of this book is entitled "The Mathematical Model," and is intended to "present in a concise and usable form the essence of that mathematics which is of direct interest in solving partial differential equations by electric analogs." Provided the reader has previously studied these mathematical subjects, he will find this part to be a useful summary. There are satisfactory derivations of Laplace's equation, the diffusion equation, and the wave equation, but the classification of partial differential equations is very woolly. There is an adequate review of conformal and integral transforms. The treatment of finite difference approximations does not use the notation of the calculus of finite differences, which will probably suit the majority of readers very well. The minority, on the other hand, will be irritated by the resulting cumbersome expressions.

The second part is a description, with copious hints and references, of the different physical models which can be used for the numerical solution of partial differential equations. Those treated are: conducting sheets, conducting liquids, resistor networks, RC networks, LC networks, RLC networks, non-electric analogues, and assemblies of feedback amplifiers. This last is useful in contrasting with the more common application of feedback amplifiers to problems with one independent variable only.

Part three covers the same ground, in a perfectly acceptable way, classified by the type of equation dealt with. Examples are given, for each type, of the situations in which it arises, with remarks on models that have been used. The biharmonic equation is included, because of its importance in the analysis of structures.

A particularly good feature of *Analog Simulation* is the references to other literature, and there is also an index. Although the book is not perfect, it should be very useful to the engineer who needs solutions of partial differential equations, and who has a good mathematical background.

G. C. TOOTILL

Chemistry of Semiconduction

Semiconductors. Edited by N. B. HANNAY. American Chemical Society Monograph Series. *Reinhold, New York; Chapman and Hall, London.* (120*s*)

You might say, at first glance, that this was just another textbook on semiconductors, where the unspecialised reader, having been led gently through the introductory chapters, finds himself suddenly floundering in a morass of quantum mechanics. You would be wrong on two counts. For in this book brute mathematical description, the terror of many of us, is kept to a minimum; and further, the emphasis is different to the usual run of semiconductor textbooks.

There cannot and never will be a hard and fast rule dividing chemistry from physics. Nowhere is this felt more keenly than in the field of semiconductor research, where the physicist works hand-in-glove with the chemist, where physical and chemical modes of thought rub shoulders in theoretical descriptions. However, since the advent of the transistor in 1947, the text books have had, inevitably perhaps, a strong physical bias, and it is stimulating to come across a book that attempts to redress the balance, a book which, in the words of Dr. Hannay of Bell Telephone Laboratories, its editor, "intends to present the science of semiconductors from a chemical point of view."

The book is a success, there is no doubt about that. Each chapter is written by an author active in his own field, which makes for a well-balanced book, and although repetitions and differences of notation occur they are not serious. The matter is clearly written and the book as a whole, easy to read. It is a peculiar fact that scientific articles, like business letters, look as if they have all been written by the same person, and this collection is no exception—the style is basic scientific English (or, rather, American) throughout. A uniform style may be desirable for the dissemination of objective knowledge but I feel it is lamentable when it goes over to introductory, discursive, and speculative passages, for here we need the author's individuality and insight to show. After all, science is not such a

cold, unemotional thing as many, many textbooks would have us believe. In ignoring this most of the authors reviewed here merely follow the usual fashion.

The range of subjects to be found is wide. Where the book has economised on the mathematical details of theory it has been extravagant in scope, as a glance at the following list of chapters and authors will show: Semi-conductor principles (N. B. Hannay), Survey of semiconductor chemistry (J. J. Lander), Semiconductor crystal growing (M. Tanenbaum), Control of composition by freezing methods (C. D. Thurmond), Defect interactions (C. S. Fuller), Diffusion in germanium and silicon (H. Reiss and C. S. Fuller), The chemistry of some compound semiconductors (D. G. Thomas), Group IV semiconductors (T. H. Geballe), Properties of some covalent semiconductors (J. M. Whelan), Infra-red absorption (H. J. Hrostowski), Recombination and trapping (R. G. Shulman), Imperfections in germanium and silicon (J. N. Hobstetter), Properties of some oxides and sulphides (A. R. Huston), Oxides of the 3d transition metals (F. J. Morin), Organic semiconductors (C. G. B. Garrett), Semiconductor surfaces (J. T. Law), and Semiconductor electrodes (J. F. Dewald). There is an ample bibliography at the end of each chapter, and a good index.

Semiconductors is certainly one of the best publications on the subject, and I have no hesitation in recommending it alike to the man who wants to know something about the subject and to the specialist who wants to catch up on progress in other branches of the field. In view of the recent discovery of transistor-like action in living tissue Dr. Garrett's article is particularly topical; and also very well written.

The book itself is beautifully produced and very expensive, like most American publications.

B. K. RIDLEY

Classical Masses in Motion

The Dynamics of Particles and of Rigid, Elastic, and Fluid Bodies. By ARTHUR GORDON WEBSTER. Second Edition. *Dover Publications, New York; Constable, London.* (19*s*)

After having been out of print for over thirty years, the 1912 edition of Webster's " Dynamics" has now been reissued by Dover Publications in their paper-bound series of scientific classics. In the words of the publisher—" physicists, advanced engineers, mathematicians and teachers will find in it material omitted from more specialised texts, and it will serve as an excellent background to studies of motion, rocketry aerodynamics, advanced dynamics, etc." On the whole this claim is justified. There are of course many excellent modern texts (such as Goldstein's *Classical Mechanics*), which provide a sounder basic approach to the subject. But Webster's easy style and physical approach, his lack of vector notation and lengthy " explanations " may have its own appeal to some readers.

The material is divided into three parts. The first is concerned with the fundamental dynamical principles of Hamilton and Lagrange. This is familiar ground to most students of advanced dynamics. The second part deals with the dynamics of rigid bodies; this is less condensed than in more recent texts. The chapter on rotating bodies is particularly useful. Part three begins with a discussion of potential theory; this chapter also contains a remarkable amount of the basic mathematics of physics—Laplace and Poisson's equations, Green's theorem, curvilinear coordinates, spherical harmonics and so on and is a worthwhile source of reference. The final chapters deal with stresses and strains of deformable bodies, hydrostatics and hydrodynamics. Dover Publications are to be complimented on returning yet another almost forgotten classic containing so much wealth of material in one volume.

WILLIAM WALKINSHAW

Applied Aerodynamicist

Jakob Ackeret. Zeitschrift für angewandte Mathematik und Physik. Vol. 9*b*. *Birkhauser Verlag, Basle, Switzerland.* (24 *SFr*)

Jakob Ackeret is Professor of Aerodynamics at the Eidgenossische Technische Hochschule in Zürich, and a distinguished engineer of international reputation in the field of applied fluid mechanics more generally. His pupils, colleagues and friends banded together last year to produce this *Festschrift* in honour of his 60th birthday.

Introductory chapters describe Ackeret's career and his place in Swiss engineering. They portray a clear-thinking analyst and versatile experimental worker who is also gifted with the engineer's creative imagination to a high degree. A further portrait which emerges from this account is that of his Institut für Aerodynamik. This is particularly interesting in view of the attention which has been paid, in the current debate on engineering education, to the work of the great universities of technology on the Continent. The relatively autonomous specialised Institut is a typical feature of the Technische Hochschule. Here we see it at its best, flourishing under the combined benefits of inspired leadership and a lively interchange of ideas with industry.

Himself a pupil of Stodola at the ETH, Ackeret returned there as Professor in 1931 and formed his Institut in 1934. In the meantime he had spent five years at Göttingen with Prandtl, in the heyday of the Göttingen school of fluid dynamics, and four years as chief hydraulic engineer with the firm of Escher-Wyss. The wide scope of his interests at Göttingen set a pattern for his subsequent work, which has ranged from the history of hydraulic machines to astronautics, and has included practical contributions to the development of such diverse flow machines as the Kaplan turbine, the supersonic wind tunnel, and the closed-cycle gas turbine. He has also maintained his close association with Escher-Wyss, notably in their work on gas turbines.

The forward-looking character of much of Ackeret's work is very striking to an aeronautical engineer. His paper of 1925 on " The forces on aerofoils moving faster than sound " is a classic of the theory of high-speed aerodynamics. (It was Ackeret who proposed the name " Mach number " for the ratio of flight speed or flow speed to the speed of sound, in 1927.) He led the field in the development of the modern closed-circuit supersonic wind tunnel with the construction of his 40-cm tunnel at Zürich in 1933. His work on boundary-layer control by suction goes back to the early nineteen-twenties, and he was one of the first to appreciate the significance of interactions between shock waves and boundary layers in transonic aerodynamics. It is pleasing to note that the Royal Aeronautical Society elected him an Honorary Fellow last year.

The greater part of this volume, some 750 pages, is made up of 58 scientific papers contributed for the occasion. It would be impossible to give an adequate summary of them here. Twenty-four are in English and the rest are in French and German, generally with English summaries. Most of them are fluid-mechanical. About half deal with flows in turbo-machines and cascades of aerofoils, heat transfer and boundary layers, or techniques of experimental fluid mechanics. Other topics include vibration engineering, magneto-aerodynamics, and space flight. Among the authors are A. Betz, A. Busemann, H. L. Dryden, S. P. Hutton, W. R. Sears, E. Sänger, E. Schmidt, and A. H. Shapiro—to pick out a few names which will be known to readers of ENGINEERING.

Detailed review of the scientific papers is in any case made superfluous by the sensible decision of the compilers to publish this *Festschrift* as a bumper-sized double issue of the Swiss *Journal of Applied Mathematics and Physics* (ZAMP), instead of simply producing another volume to grace, and be overlooked on, the " Miscellaneous " shelves of our libraries. Published in this way the contents are much more likely to come to notice through ordinary channels. If at the same time the compilers have advertised the existence of this relatively young but already well-established journal, which regularly includes contributions of engineering interest, often in English, that is a useful service too. Among Ackeret's many hats, incidentally, is that of one of its board of editors.

E. P. SUTTON

Properties of Hot Air

Tables of Thermodynamic Functions of Air for the Temperature Range 6,000-12,000 deg. K and Pressure Range 0·001-1,000 atm. By A. S. PREDVODITELEV, E. V. STUPOCHENKO, E. V. SAMUILOV, I. P. STAKHANOV, A. S. PLESHANOV and I. B. ROZHDESTVENSKII. Translated from the Russian (USSR Academy of Sciences, Moscow). *Cleaver-Hume Press, London.* (63*s*)

The first of a series of three to be translated, this book may be regarded as volume two. Volume one will cover 1,000° K to 6,000° K and volume three from 12,000° K to 20,000° K. The series is part of a Russian programme on the properties of gases at elevated temperatures and includes the gas dynamic and thermodynamic parameters of air flow behind normal and conical shock waves for gas velocities up to 15,500 metres per second. The tables would seem to be primarily for work in high-speed aerodynamics, though temperatures and pressures in the range considered have long been encountered in geophysics and astrophysics. The present series does not present the gas dynamic properties.

There is at least one other set of tables covering this temperature range (*Properties of Argon-free Air to* 15,000° K, by Hilsenrath and Beckett (1956). Arnold Engineering Development Centre (AEDC) USA, Report No. AEDC T.N.-56-12), but it is not readily available. The usual tables which cover conventional high temperatures only go up to about 3,500° K, so no comparison was

Continued on next page

made. (These tables are: *Gas Tables*—Keenan and Kaye, 1948, Wiley; these include air properties for low pressures with temperatures up to 6,400° F absolute: and *Circular* 564, National Bureau of Standards (NBS), 1955, USA: these include air properties for pressures of 0·01 to 100 atmospheres for 100° K to 3,000° K.)

The tables in the Russian volume are presented in two parts. The first is devoted to tables of specific internal energy μ, specific enthalpy h, specific entropy S, specific heat at constant volume Cv, specific heat at constant pressure Cp, the ratio of specific heats γ (Cp/Cv), and the velocity of sound in the gas a; while the second includes tables of density and the molecular fractions of the constituents, there being thirteen of these: N, O, Ar, N_2, O_2, NO, N^+, O^+, Ar^+, N_2^+, O_2^+, NO^+, and e.

It is necessary here to say a few words about these constituent fractions as some are never met with in conventional engineering. The fractions O_2 and N_2 are the normal oxygen and nitrogen molecules, O and N are the atomic forms of oxygen and nitrogen and NO is a combination of the nitrogen and oxygen atoms. These last three forms are formed by dissociation of the O_2 and N_2 molecules but their proportions do not become noticeable till about 1,500° K. At temperatures about 5,000° K ionisation of the gas becomes noticeable and a free electron gas (e) is formed thus leaving positively charged atoms and molecules ,O_2^+ and so on. A good relatively obtainable discussion of gas properties at high temperatures is available (*Thermodynamic Properties at High Temperatures. Ideal Gas Thermodynamic Functions up to 25,000° K for Diatomic Molecules O_2, N_2, NO and their Molecule Ions*, by Beckett and Haar. This is part of a symposium held jointly by the International Union of Pure and Applied Chemistry and the Institute of Mechanical Engineers. *Proceedings of Conference on Thermodynamic and Transport Properties of Fluids*, 10 to 12 July, 1957. Published by the Institution of Mechanical Engineers.)

The properties of air are given in the tables at intervals of 100° K for 97 different pressures. The c.g.s. system is used throughout. A brief description of the work involved in the preparation of the tables is given and it is worthwhile to point out the salient features. Firstly, the thermodynamic functions and the equilibrium constants are calculated by statistical methods from fundamental spectroscopic data for each temperature and pressure; then the set of thirteen non-linear algebraic simultaneous equations are solved for the constituent fractions. This is a mammoth task and could not have been undertaken without a high-speed digital computer. Interpolation formulae are given and an example worked out. It should be stressed that a consistent error has been made throughout the tables. This must have been found after tabulation was complete. A correction table is given but this could be easily missed. A list of references is given at the back of the book.

The tables presuppose equilibrium conditions and care must be exercised in their use as in many problems the constituents may not have time to reach equilibrium.

W. DRUMMOND

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Air

Axial Flow Fans. FREER FANS LTD., Fleet Mill, Minley Road, Fleet, Hants. Axial flow airscrew fans in sizes from 1 ft to 15 ft diameter. Built-in motors, light weight. Leaflet.

Compressed Air Equipment. VICTOR PRODUCTS (WALLSEND) LTD., Wallsend-on-Tyne. Driers, water traps, couplers and filters for compressed air lines. Brochure No. CA100.

Centrifugal Fans. KEITH BLACKMAN LTD., Mill Mead Road, London, N17. Tornado centrifugal fans, blowers, and exhausters shown with various discharge arrangements. Leaflet.

Compressor. HYMATIC ENGINEERING CO. LTD., Redditch, Worcs. Type 98P100 compressor for pneumatic tools; delivery 72 cu. ft per minute, working pressure 100 lb per sq. in. Mounted on two-wheel chassis. Leaflet shows applications.

Materials

Plumbago Stoppers. MORGAN CRUCIBLE CO. LTD., Wandsworth Works, Point Pleasant, London, SW18. Salamander plumbago stoppers and nozzles for crucibles and ladles. Leaflet.

Soil Testing. SOILTEST INCORPORATED, 4711 W. North Avenue, Chicago 39, Illinois, USA. Comprehensive 300 page catalogue of soil testing equipment of all types.

Weight Calculator. UDDEHOLM LTD., Crown Works, Northwood Street, Birmingham 3. Slide rule calculator for obtaining the weight of steel strip in English and metric units.

Pipe Lagging. STILLITE PRODUCTS LTD., 15 Whitehall London, SW1. Stilclad preformed sections for pipe lagging; made of mineral wool. Up to 4 in outside diameter pipe. Particulars given in data sheet 15/59.

PVC and Nitrile Rubbers. BRITISH GEON LTD., Devonshire House, Piccadilly, London, W1. Technical information on vinyl resins, latices and compounds, and on Hycar nitrile rubbers and latices. Data book No. 1.

Silicones. MIDLAND SILICONES LTD., 68 Knightsbridge, London, SW1. Engineering guide to the use of silicone fluids gives characteristics and typical applications. Folder G11.

High Nickel Alloys. HENRY WIGGIN & CO. LTD., Wiggin Street, Birmingham 16. A list of current publications on high nickel alloys. Also 90 page booklet describing the relationship between high nickel alloys and sulphuric acid.

Titanium Jigs. IMPERIAL CHEMICAL INDUSTRIES LTD., Millbank, London, SW1. Anodising, electropolishing and galvanising with titanium jigs. Leaflet.

Paper Testing. PRINTING PACKAGING AND ALLIED TRADES RESEARCH ASSOCIATION, Patra House, Randalls Road, Leatherhead, Surrey. Test bench facilities for the testing of paper and inks. Illustrated brochure gives full details.

Belting. GRATON AND KNIGHT LTD., Warwick Road, Boreham Wood, Herts. Nycor belting with interleaved woven nylon fabric. Great strength without stretch. Four types for belt speeds up to 10,000 ft per minute. Leaflet gives details.

The Reviewers

Mr. G. C. Tootill, M.A. (Cantab.), M.Sc. (Manchester), A.M.I.E.E., is on the staff of the Royal Aircraft Establishment. For the past 13 years his work has been connected with automatic computers, both analogue and digital.

Dr. Brian Kidd Ridley is engaged at the Mullard Research Laboratories in theoretical and experimental work on recombination, transport and diffusion phenomena in germanium and silicon. He was previously at the University of Durham, where he presented a thesis on colour centres in alkali halides. He is a B.Sc., a Ph.D. and an A.Inst.P.

Mr. W. Walkinshaw, M.A., is deputy chief scientist in the theoretical physics division at the Atomic Energy Research Establishment, Harwell.

Mr. E. P. Sutton, M.A., A.F.R.Ae.S., is lecturer in the department of engineering, Cambridge University, and fellow of Pembroke College. He worked at the Royal Aircraft Establishment from 1945 to 1956, first at Farnborough and then at the new laboratories at Bedford, mainly on high-speed aerodynamics.

Mr. William Drummond is engineer in charge of reactor physics and performance in the atomic energy department of Babcock and Wilcox Limited. He took an external B.Sc. (Eng.) at London University and obtained first class honours, and in 1953 attended a post-graduate course in thermodynamics at the University of Glasgow. He is an associate member of the Institution of Mechanical Engineers.

New Books

CABMA Register of British Industrial Products for Canada, 1959-1960. *Published for the Canadian Association of British Manufacturers and Agencies by Kelly's Directories and Iliffe.* (15*s*)

The buyers' guide section covers some 3,000 British products available to the Canadian market, together with a French glossary of terms used, while the appended directory lists nearly 4,000 British firms together with their Canadian distributing agents.

Strength of Materials. By JOHN CASE and A. H. CHILVER. *Edward Arnold.* (35*s*)

This volume, together with the authors' *Advanced Strength of Materials*, forms a completely fresh edition of Professor Case's book, of which the third edition appeared in 1938. First and second year undergraduate requirements are covered.

A Digest of Elementary Chemical Thermodynamics. By D. SHIREBY. *Pitman.* (20*s*)

Intended for those who have had little or no previous introduction to the subject. The essential facts and principles are given in a simple compact form, illustrated by worked examples.

Fundamentals of Nuclear Energy and Power Reactors. By HENRY JACOBOWITZ. *John Rider, New York; Chapman and Hall, London.* (24*s*)

An introduction to the field written for those with a general interest in the subject, as well as the growing numbers in the nuclear industries. Many simple diagrams and illustrations are given.

Theoretical Elasticity and Plasticity for Engineers. By D. E. R. GODFREY. *Thames and Hudson.* (42*s*)

Intended as a further stage to normal strength of materials studies, this is equally suited to degree level mathematics courses. The presentation is well adapted to personal study.

Manual of Mathematical Physics. By PAUL I. RICHARDS. *Pergamon Press.* (£5 10*s*)

Information on theoretical physics and allied mathematical techniques is presented here in a continuous, rather than dictionary form, but it is claimed that each term and concept above the level of elementary calculus is defined.

Mathematical Programming and Electrical Networks. By JACK B. DENNIS. *The Technology Press of the Massachusetts Institute of Technology* and *John Wiley, New York; Chapman and Hall, London.* (36*s*)

Professor Dennis's book is the third in a series of research nomographs designed to fill the gap in time between periodical articles and finished books. Here is offered a new approach to mathematical programming based on an analogy with electrical circuits.

Elementary Mechanics. By D. A. QUADLING and A. R. D. RAMSAY. Volume 2. *G. Bell.* (17*s* 6*d*)

While this volume has not been written with one particular examining body in mind, the level is suitable to many engineering degree course first year examinations. The third volume of the work is to cover two-dimensional motion of rigid bodies, equivalent systems of forces and conservative fields.

Nomography. By ALEXANDER S. LEVENS. 2nd edition. *Wiley, New York; Chapman and Hall, London.* (68*s*)

This new edition has been very substantially enlarged, and contains three completely new chapters: on circular nomograms; projective transformations; and the relationship between Cartesian and alignment nomograms.

Open-Channel Hydraulics. By VEN TE CHOW. *McGraw-Hill Publishing Company, New York and London.* (132*s*)

The theory and practice of design for flow in open channels and related structures, dealing mainly with current American practice, but the references, over 800 of them, reflect progress in other parts of the world.

Marketing

Changing Trends in Exports

The increased exports and imports of January show some important changes in direction for cars and commercial vehicles, for aircraft, though less so for aero-engines, in trade with the Soviet European satellites, and in iron and steel.

Board of Trade figures for January show exports running at £316 million for the month, re-exports at £12 million, and imports costing £367 million.

Exports in the three months from November last year to this January are 4 per cent greater in value than in the previous quarter. Imports had increased in cost by twice as much—8 per cent.

In the detailed breakdown it appears that engineering products accounted for half of the rise in the value of exports. Non-electrical machinery exports rose by almost a fifth. The great rate of improvement in selling to the United States is slowing down; there was still an increase of 18 per cent but the increase had before been of the order of 25 per cent. By way of compensation trade with Canada is at long last beginning to pick up.

The success story of British car exports continues accelerating. Cars enjoyed a 41 per cent increase in export performance and commercial vehicles and chassis improved by 22 per cent. The movement in aircraft and parts, excluding engines, was downward—by 28 per cent—compared with the export figures of a year ago. Exports of ships were still falling and there was a sharp drop in the value of rail vehicles sent abroad.

The biggest change in trade with the various areas of the world was the 27 per cent increase in exports to Soviet Eastern Europe. There was also a 17 per cent increase in exports to Western Europe. The value of these exports was £84 million to Western Europe and almost £7 million to Eastern Europe.

Eight Car Firms on One Ship

The largest cargo of unboxed British cars for export to the American west coast sailed from Purfleet for the main ports of the United States Pacific coast on the Cape Sable of the Glasgow LYLE SHIPPING Company.

In all, 1,082 cars made by AUSTIN, MORRIS, JAGUAR, VAUXHALL, FORD, ROOTES, STANDARD and ROVER were aboard, stacked six deep through three extra car decks in the lower holds and one in the 'tween decks.

The Cape Sable has been taken on long term charter for car carrying.

Gearbox Output at David Brown

A 60 per cent rise in production from 1958 to 1959 is a striking claim—it is made by the DAVID BROWN Automatic Gearbox Division who report this leap in their gearbox output. The company expects that the present rate of production will be maintained throughout this year, it is certainly keeping up the pressure with the introduction of a new six-speed model to its commercial range.

The David Brown model 552, for use in vehicles of 14 to 16 tons with either petrol or diesel engines, first went into batch production four months ago and has already earned contracts worth £70,000 from one user. Negotiations with a number of other commercial vehicle manufacturers are going on at the moment.

Heights and Depths in American Profits

The great companies of the United States are not expected to do anything by halves and their profits returns now becoming available for 1959 show some mighty changes in both directions. From the sample so far published FORD showed the most rapid improvement. A Ford profit of $116,200,000 in 1958, fifteenth from the top of the list, climbed all the way to third place in 1959, to a profit of $451,400,000.

GENERAL MOTORS, which led the field with $634 million in 1958 still led last year, with $873 million. All the company returns were achieved despite the effects of the longest steel strike known on the continent. The car assembly firms and the component companies still achieved a 90 per cent increase in their profits. Without the steel stoppage the 1959 car firm profits might perhaps have more than doubled those of depressed 1958.

A general average increase over the corporations so far known of 22 per cent on the profits is indicated and it is further evidence of America's post-war power to pull out of recession conditions. The profit gain may have been appreciably higher than 22 per cent since almost every major steel company has already reported and this has had some effect in holding down the average.

Early returns from the aircraft companies shows them running a deficit although some of the more important results are still to come. The DOUGLAS corporation fell from a $16,800,000 profit in 1958 to a loss of $33,800,000 last year.

Between the extremes of soaring car profits and aviation firms going into the red, results vary from almost 60 per cent profit increases in the textile companies, almost as great rises in metal fabricating, profits up half again on 1958 in appliances and other consumer products and railroad equipment increasing by 25 per cent and building materials by more than 20 per cent.

Further Education Extension Contract

HOLLAND & HANNEN AND CUBITTS (NORTH WEST) Limited are to carry out a £650,000 extension programme for the Harris College of Further Education at Preston, Lancashire. Together with the London consulting engineers, A. J. and A. D. Harris, Cubitts have worked closely with the Ministry of Education Development Group from the design stages of the project.

The 48,609 sq. ft main four-storey teaching block will include departments of electrical engineering, physics, chemistry and biology. There will be a single storey laboratory for heavy engineering, a mechanical engineering workshop and a building workshop.

Car parks and bicycle sheds are being fitted into the college area, which will be surrounded with landscaped grounds.

Grand Bahama Limits Taxes to Aid Growth

Rapid growth in the development of the largest island in the Bahaman colony—Grand Bahama—has been achieved, partly because of the favourable tax position created in the agreement to develop an industrial, commercial and residential area at Freeport.

The agreement was reached in 1955 between the Grand Bahama Port Authority and the British Government of the Bahamas.

Freeport, which is 81 miles from Florida in the United States, now has a properly dredged deep water harbour spreading over a million square feet with a 200 ft wide channel.

The list of industries which have been started up on the island includes shipbuilding, repair and scrapping, mechanical and electrical engineering, glass making, quarrying and lumbering, chemical fertiliser production, hydroponic farming, and there has been much construction of buildings, roads and bridges.

The tax concessions fixed in the agreement provide that until 2054 the Port Authority and its licencees pay no import duties, apart from those on goods for personal use or gift.

Until 1985 no real property taxes or levies will be made against any land, building or structure in the Freeport area.

Until 1985 the Authority and its licencees will be free from personal property taxes, capital levies, capital gains taxes, capital appreciation taxes or taxes of any kind on their earnings in the Freeport area.

Until 1985, employees of the Authority or its lessees and licencees living in the Freeport area will pay no income tax.

Until 2054 the Authority and its licencees will pay no excise taxes, except on imported consumable goods, no export taxes or levies and no stamp taxes on bank remittances.

For the British manufacturer interested in setting up within such handy striking range of the North American market, it is worth adding that there is at the moment an adequate labour force on the island, though mostly unskilled, but the British West Indies has more varied manpower resources and the Port Authority has wide powers to allow the immigration of skilled labour.

Re-equipment of James Booth

The first step in the £5 million expansion and re-equipment programme of JAMES BOOTH ALUMINIUM is the placing of an order for what will be the largest aluminium rolling mill of its class in Western Europe.

Costing some £1½ million, and expected to be operational at the Kitts Green, Birmingham, works next year, the mill will be capable of rolling slab ingots of aluminium and Duralumin of up to six tons.

Much of the increased demand which the expansion programme is designed to meet is expected from the chemical plant makers and the building industry. When the KAISER ALUMINIUM AND CHEMICAL CORPORATION of the United States bought a 50 per cent interest in James Booth, a DELTA METAL subsidiary in January, the Kaiser contribution of £5 million gave the company the capital necessary for the new capacity.

Airports at a Loss

Amid all the clamour to sell parts of the British Transport Commission's organisation, the rest of British Road Services, and the still-nationalised steel firms back to private enterprise no voice is raised asking for the airports to be turned over to private interests.

Not surprisingly. Of the 26 airports in the United Kingdom operated by the Ministry of Transport in the year 1958-59 every one showed a loss. The total deficiency was £6,366,247.

The three international airports, which are among the 15 which it is hoped will eventually become self-supporting, lost £3,600,000. These are Prestwick, Gatwick and London.

A smaller loss, incurred in running services to meet social requirements, was the deficit of £463,645 made in running the eight airports for the Western Islands and the Highlands.

Underground Farms

The manufacturers of lamps would enjoy an expansion beyond their wildest dreams if the prediction of the farms of the future going underground to escape the weather were to come true.

This imaginative proposal is made by Mr. Robert Zahour, who is manager of application engineering for the WESTINGHOUSE LAMP DIVISION of the United States WESTINGHOUSE ELECTRIC INTERNATIONAL Company. According to Mr. Zahour, agricultural research stations in America have discovered a narrow band of rays of light from incandescent bulbs and fluorescent lamps which are thought to be largely responsible for plant growth.

If in future farms go underground out of the way of unwanted temperature fluctuations, weather conditions and plant diseases, then perhaps beneath Alaska and Siberia bananas, grapefruits and other fruits of the tropical regions would flourish—all under artificial lamps.

Mr. Zahour lectured, evidently with enthusiasm, to the Massachusetts Horticultural Society. He recalled that some years ago he and a plant research specialist planned a long-term "underground" greenhouse project to find out how much artificial light was needed to maintain house plants in proper health. After some years the specialist found several plants which would grow satisfactorily with artificial light at levels equal to those of a modern office or under a reading lamp in the home.

East-West Orders for Elliott

ELLIOTT-AUTOMATION has secured orders for computers in the United States and for the full instrumentation of a Romanian oil refinery.

Six Elliott 803 computers to be sent to the United States cost from £16,000 to £20,000 depending upon the complexity and requirements of the design.

The Canberra: Liner of Modern Design

The largest British passenger liner to be built since the Queen Elizabeth, the 45,000 ton Canberra has aluminium superstructure, a quickly reversible docking propeller, and will cut travel time to Australia by one week.

Designed for Australia and the Pacific, the P and O Canberra will have accommodation for 600 first class and 1,585 tourist class passengers, 1,000 crew and 150,000 cu. ft of cargo. Her main propulsive machinery is turbo-electric, developing 85,000 h.p. and, it will give the ship a service speed of just over 27 knots. This means that she will be able to reduce the UK to Sydney run from four weeks to three.

The ship is due to be launched at Belfast by the builders, Harland and Wolff, later this month. The twin-screw propelling machinery was made by the AEI Heavy Plant Division at Rugby. The machinery is designed for 68,000 s.h.p. at 136·5 propeller r.p.m. normal service, and 85,000 s.h.p. at 147 propeller r.p.m. maximum continuous. Fig. 1 shows one of the two 32·2 MVA turbo-alternators and Fig. 4 the way in which the ship is laid out

It was decided to have the engines aft, as shown in Fig. 4, in order to allow the midship portion of the ship for public rooms and passengers. After exhaustive tests it was decided to have a hull with a beam of 102 ft, a draught of 32 ft 6 in and a length of 820 ft, complete with a bulbous bow having a diameter of about 14 ft made up of a steel casting weighing 33 tons. Such a bow form leads to increased propulsive efficiency in a high speed ship like the Canberra. Exposed or naked shafts, supported by specially designed "A" brackets, are also favoured.

Two sets of stabilising equipment of the Denny Brown type are to be fitted, each of which consists of two fins that extend in their working position from the hull, port and starboard. They are retracted into the hull when not in use. Control of the angle of incidence of these fins, and hence the righting moment applied, is by small electrically-driven gyroscopes that actuate through electric and hydraulic relays. Power for operating each fin is supplied by an electrically-driven, variable-delivery pump.

It was found that by using aluminium for the superstructure 1,500 tons could be saved, so that another deck could be used and about 250 more passengers accommodated. The Canberra therefore has a fully-welded superstructure, made up of more than 1,000 tons of aluminium to make it the biggest all-welded aluminium ship's superstructure. Panels of deck plating and deckhouse sides are prefabricated in the welding shops by the inert-gas, metal-arc process, using both automatic gantry and manually-operated machines. The deck panels are up to 30 ft square and are complete with deckbeams, ready for erection on board, where they are welded to neighbouring panels. The deep deck girders are also prefabricated from plate webs and heavy bottom flanges, cut from plate or extruded sections. This method of manufacture gives the designer an unlimited choice of strength properties for each length of girder, which could

Continued on next page

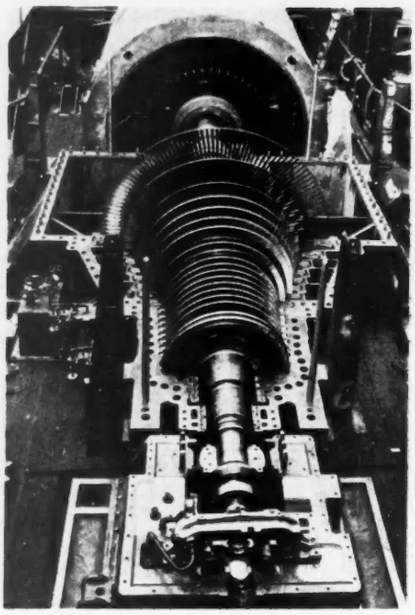
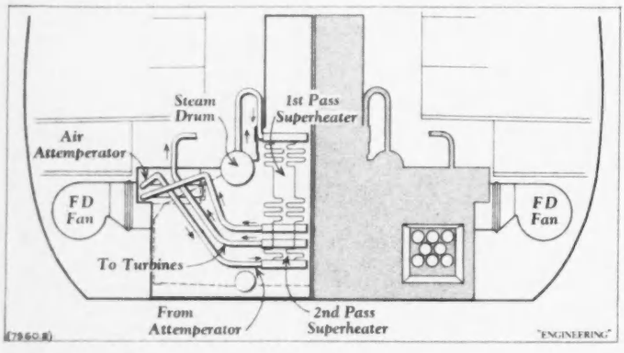
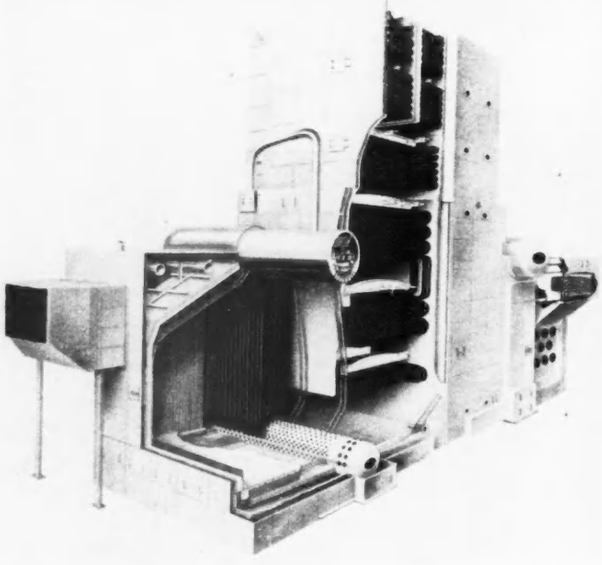


Fig. 1 (above right) One of the two 32·2 MVA turbo-alternators.

Fig. 2 (below) Main boiler layout, showing the steam flow through the superheater and attemperator.

Fig. 3 (right) Foster Wheeler external superheater D type boiler.





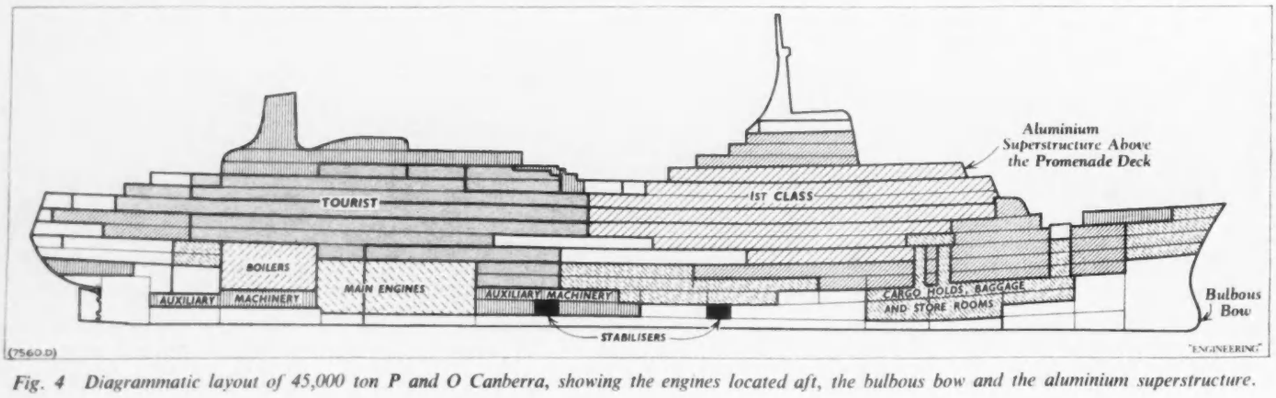


Fig. 4 Diagrammatic layout of 45,000 ton P and O Canberra, showing the engines located aft, the bulbous bow and the aluminium superstructure.

only be matched in extruded sections by having a large number of costly dies.

Before building the superstructure, Harland and Wolff invited the cooperation of the British Aluminium Company in the design and construction of a representative portion of the superstructure. This provided practical experience in making the many welded joints likely to be employed and confirmed that the design proposals were well suited to the material. Some of the plates delivered were welded at the British Aluminium Company's rolling mills at Falkirk, where plates up to 14 ft wide can be made by automatically welding together two 7 ft wide components. This is the maximum width of plate that can be hot rolled but greater widths are often preferred by shipbuilders since the 'tween deck height is seldom less than 7 ft 6 in.

An interesting development in the Canberra is the docking propeller, mounted in an open transverse tunnel near the bows of the ship. The thrust of this propeller can be controlled from 9 tons down to about 2 tons. It can also be reversed quickly by means of a simple controller on the bridge. A slip-ring a.c. induction motor provides the motive power through an oil-operated reversing gear box. The stored kinetic energy of the uni-directional continuously running motor is used to reverse the propeller rapidly, thereby eliminating the heavy starting current surges that would be involved with a conventional traversing motor, not to mention the unsatisfactory slugginess of such an arrangement.

The Canberra has three main boilers and one auxiliary boiler, all four of which are arranged aft, as will be seen from Fig. 4. This installation (Figs. 2 and 3) includes Foster Wheeler Limited external superheater D type (ESD) boilers, which have the superheater located in the gas flow after the boiler, so that it receives heat by convection. Control of the superheat is by an air attemperator consisting of extended surface tubing through which the steam flows continuously on its way between the first and second passes of the superheater. Combustion air is used as the cooling medium and the proportion needed is regulated by dampers.

In the article " Multileaf Spring Design," in our issue of 22 January, we omitted to mention that the tests and rational analysis of the Toledo Woodhead springs were carried out by Plint and Partners Limited, Wargrave, near Reading, Berks.

Diesel-Electric Lighthouse Tender

An interesting vessel recently completed at Cowes, Isle of Wight, by J. Samuel White and Company Limited is the twin screw diesel-electric ship Siren. She is intended for the District Tender Service of the Corporation of Trinity House and has been built to the special requirements of that body and classed Lloyds 100A1 " Lighthouse Tender." (Figs. 1 and 2.)

The Siren is the second of three sister ships to be constructed by this company. These vessels, specially designed for servicing lighthouses and lightships and maintaining buoys, will replace older vessels. For example, the Siren is destined for service at Cowes as a replacement for Beacon.

The hull form was chosen after model tests of hull resistance and manoeuvrability had been carried out at the National Physical Laboratory, Teddington.

Principal particulars are: length overall, 221 ft; length between perpendiculars, 205 ft 5 in; breadth moulded, 37 ft 6 in; depth moulded to upper deck, 23 ft 6 in; draught, 13 ft; speed, 13 knots; gross tonnage, 1,425; net tonnage, 455; complement (Captain, officers and crew), 44.

A considerable amount of welding has been employed in the construction, including shell butts, deck and bulkhead plating, with frames, beams and stiffeners generally riveted.

The duties for which the Siren is intended require special deck machinery. This equipment has been supplied by Clarke, Chapman and Company Limited, Gateshead.

For the purpose of moving lightships, and so on, an electrically driven towing winch is fitted in the winch house on the upper deck aft, the main motor being of 30 h.p. at 440 r.p.m. The winch barrel is 2 ft 6 in diameter by 2 ft long and carries 120 fathoms of 4½ in circular steel wire rope. Two 24 in diameter warping ends are fitted on extended shafts. The machine can wind in against a pull of 5 tons direct from the first layer of rope at 60 ft per min and withstand a maximum rendering load of 15 tons. An automatic device is fitted to the winch to ensure a balanced load.

There is a triple-headed capstan forward with electric motor on main deck driving three cable heads on the upper deck for lifting anchors, buoys, etc. Two chain pipes are led to the forward cable hold. Each head is separately operated from a common motor, complete with slipping clutch and brake, by suitable reduction and bevel gear. The motor is of 48 h.p. and is capable of a pull of 10 tons at 35 ft per min and a slack rope speed of 150 ft per min from any one capstan barrel or cable lifter at a time. Booster control is provided to avoid the necessity for large resistances. A single-headed capstan similar in all respects to the triple headed gear as regards duty, control and installation, except that one warping barrel and one cable lifter only are fitted, is situated on the foredeck with chain pipes leading to the after cable hold.

For working the 15 ton buoy lifting derrick on the foremast, two electrically driven winches, one for hoisting and one for topping, are fitted on the lower deck forward with wire trunks leading to the upper deck. Each winch has a cast steel barrel of 3 ft diameter by 2 ft long grooved to accommodate 140 ft of 4½ in circular steel wire rope. The motors are of 48 h.p. capable of a pull of 10 tons from the first layer of rope at 38 ft per min.

Two warning and guy capstans are fitted port and starboard at the fore end of the deckhouse, with motors on the main deck and capstan barrels on the upper deck. The motor is of 9 h.p. capable of a pull of 30 cwt at 50 ft per min, or 10 cwt at 150 ft per min. The steering gear has been supplied by Brown Brothers and Company Limited, Edinburgh, and is of the trunk piston type, having two electrically driven pumping units each capable of moving the rudder from hard over to hard over in 30 sec with the vessel moving at full speed. For special navigational requirements the simultaneous operation of both units will reduce the time of the gear to 18 sec.

Diesel-electric propulsion is not new to the Corporation of Trinity House, who have well tried and tested this system during the past 21 years in the Patricia, and it is interesting to note that they have again chosen this type of machinery to meet their requirements. The main propelling machinery was supplied by the English Electric Company Limited and arranged and installed by J. Samuel White and Company.

This twin-screw diesel-electric machinery operates on the controlled voltage principle, using a modified Ward-Leonard system of control. The four main generators and the propulsion motors are arranged in a series circuit and from one to four generators can provide propulsion power, while still retaining completely independent control of the propellers. The generators can be switched into (or cut out of) the propulsion circuit while the vessel is under way, without interrupting propulsion power, and the engines cannot be overloaded in any service condition or combination of generators. The inherent characteristics of the system limit the maximum power demand from the engines to their designed service rating.

Fig. 1 Siren, the second of three lighthouse tenders for Trinity House.

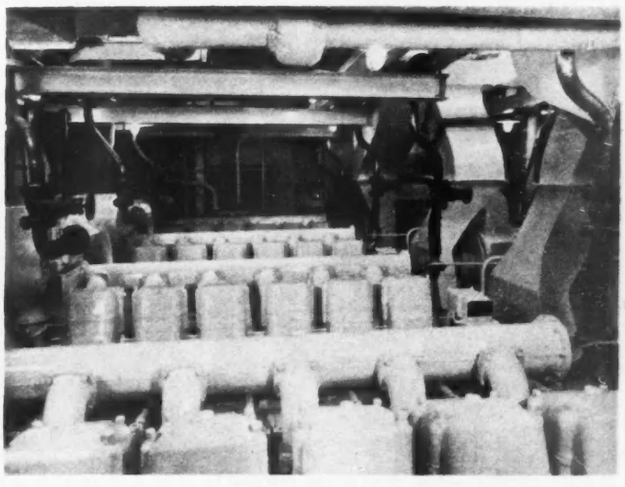
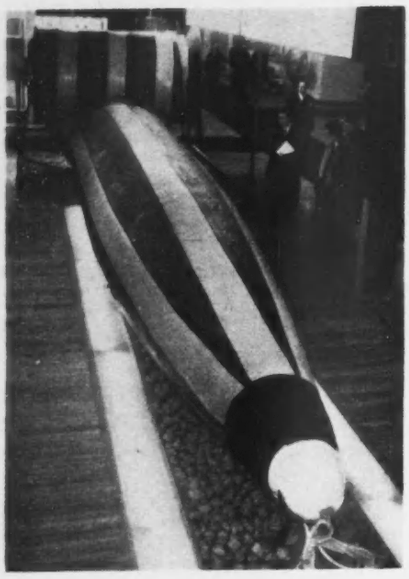
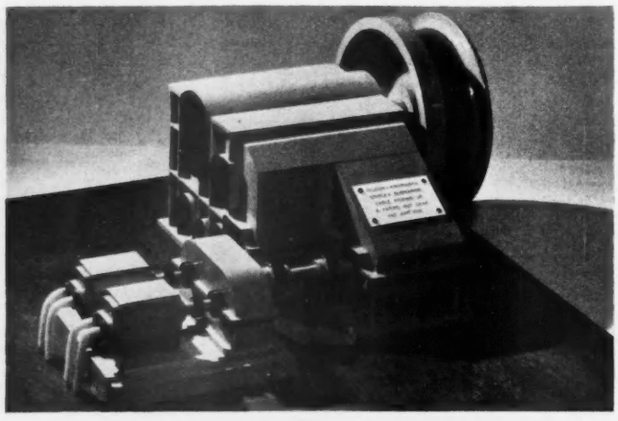


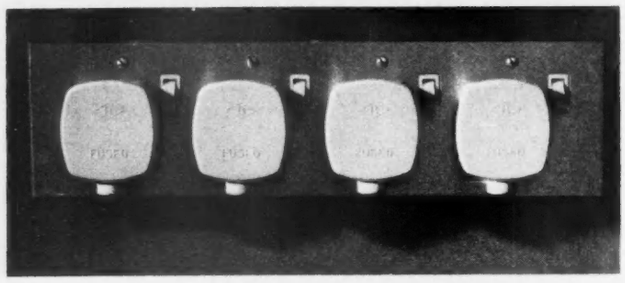
Fig. 2 View of the engine room of the Siren, showing the diesel engines.



(Left) Inflatable barge for carrying oil supplies, made by P. B. Cow and Co. Ltd. for Dracone Developments Ltd., using nylon and rubber material supplied by British Nylon Spinners Limited.



(Right) Model of electro-hydraulic picking-up and paying-out gear (Telegraph Construction and Maintenance Company Limited).



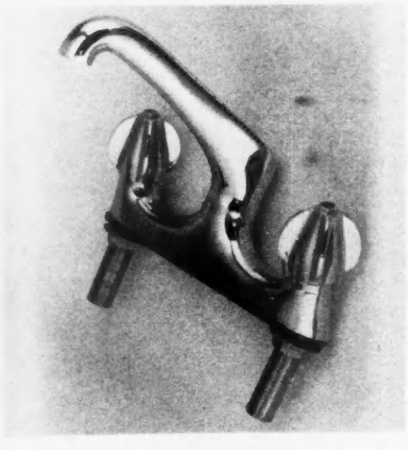
(Right) 13 amp a.c. ring main sockets and plugs made by Britmac Electrical Company Limited.

(Left) The Computronic accounting machine, made by the National Cash Register Company Limited, can multiply in sterling at high speed.

(Right) Mr. J. M. Whiteford with the working model of his cargo-handling crane of novel design which he claims will reduce cargo handling time by 50%.

(Left) British Railways driver with his hand on the indicator disc lever of the distant signal automatic warning system installed on the Southern Region.

Bus queue shelter made from 20 s.w.g. aluminium alloy sheet (Aluminium Development Association).



This sink mixer, made by Manley and Regulus Limited, is of brass with a chromium plated finish.

Thermal Stress Behaviour in Brake Drums

High thermal stresses can develop in brake drums. Expressions are determined for stresses generated during a single brake application and graphs showing the stress behaviour for some typical automobile drums are given.

By T. P. Newcomb, M.Sc., A.Inst.P.

Research Division, Ferodo Limited

During the process of braking high thermal stresses can be developed in brake drums due to the varying rate at which heat is generated at the interface of drum and lining. Cracking or complete failure of drums can occur in service and it is of interest to determine whether such cracking can be caused by thermal stresses.

In particular, two distinct cases must be considered, the first case refers to continuous braking (e.g. braking down a gradient or intermittent braking) in which the drum after an initial period attains approximately a uniform temperature and consequently expands uniformly. The thermal stresses in such a drum are low but failure could occur due to reduced strength of the material composing the drum at very high temperatures. The second case is concerned with a single brake application to bring the vehicle to rest at a uniform deceleration. If the brake application is violent and of short duration then initially there is a rapid build up of temperature at the friction surface. Furthermore, in the short interval of time after commencement of braking a high temperature gradient exists across the drum thereby resulting in compressive stresses at the friction surface and somewhat lower tensile stresses near to and at the outside of the drum. The thermal stresses involved when such an application is made to a drum initially at a low temperature may be sufficiently high to enable surface cracking to develop.

In this article, after briefly discussing the temperature reached at any instant in a single brake application, the stresses acting at any depth inside the drum are calculated. The method adopted is similar in principle to that described in a previous paper on this subject given by Hasselgruber.[1] However, his solutions are only true for thick brake drums or for a very short period after commencement of braking whereas the equations derived below are applicable to a drum of any thickness and at any time during the brake application.

Temperatures Attained in Single Brake Application

If a vehicle of weight W lb is brought to rest from an initial velocity u ft per sec in a single brake application of duration T, then the rate of heat generation per unit area at any instant t entering the drum (all the heat is assumed to flow into the drum) is

$$H = \frac{y\,W\,u^2}{2g\,J\,A_1\,T}\left(1 - \frac{t}{T}\right) = N(1 - Mt) \quad (1)$$

where

A_1 = area swept out in drum (sq. ft)
g = acceleration due to gravity 32·2 (ft per sec²)
J = mechanical equivalent of heat (taken as 778 ft lb per Btu)
y = the proportion of the total braking force transmitted to the axle of the wheel is considered, i.e. y is generally 0·6 for the front and 0·4 for the rear axle.

The above expression contains only the translational energy contribution but the energy of the rotating parts could easily be included by addition of an appropriate mass to the weight of the vehicle (rotational energy is of the order of 5 per cent of the translational energy).

When the thermal flux given by equation (1) exists at the friction surface ($x = 0$), and it is assumed that the radius of the drum is considered large compared with its thickness and heat edge effects are ignored, the heat conduction problem is reduced to one of linear flow. At the exterior surface ($x = d$) there is little loss of heat due to cooling during a single brake application. With these boundary conditions, solutions giving the temperature increase θ at any depth x from the friction surface at any time t during a single brake application may be derived as outlined previously by Newcomb.[2] Two solutions are applicable, one for the time range $0 < t < 2s$ and the other for $t > 2s$ respectively (s denotes seconds). The equation for the time range $0 < t < 2s$ is similar to equation (12) and when $t > 2s$ the simplified equation given by equation (26) of Newcomb's paper may be used. Both solutions involve, as well as N, M and t: d the thickness of the drum, K its thermal conductivity, ρ its density, C its specific heat and α its thermal diffusivity defined as $K/\rho C$.

Figs. 1, 2, 3 and 4 show the variation of θ/N (proportional to the temperature rise) at various x/d and different times throughout a five and ten second brake application to rest using typical car brake drums of thicknesses 0·25 in (0·0208ft) and $\frac{3}{16}$ in (0·0156 ft), K = 0·00739 Btu ft$^{-1}s^{-1}$ °F^{-1}, and α = 0·0001603 sq. ft. These curves indicate that there is a steep temperature gradient across the drum immediately the brake is applied and that this gradient decreases as the rate of deceleration decreases (i.e. the time of application gets longer, remembering that equation (1) shows that N for a five second application is twice the value of N_1 for a ten second stop when braking occurs from the same initial energy) but after approximately two seconds of braking the temperature gradient is very much reduced. Furthermore, the temperature gradient is reduced by decreasing the thickness of the drum. For example, the temperature difference between the interface and $x = 0{\cdot}25d$ is 0·56N for a $\frac{1}{4}$ in drum compared with 0·35N for a $\frac{3}{16}$ in drum when the brake application is 5 sec.

Bulk Stresses in Cylindrical Region of the Drum

Consider a section of a brake drum (thickness d) shown in Fig. 5, if dz is an element of length in the axial direction a radial element of length dx is under the influence of stresses σ_z and σ_t in the axial and tangential directions, respectively. Following Hasselgruber[1] it can be shown that

$$\sigma_t = \sigma_z = \frac{E\,l}{1 - \nu}\left[\frac{1}{d}\int_0^d \theta\,dx - \theta\right] \quad (2)$$

where E = modulus of elasticity of drum material,
l = coefficient of linear expansion,
ν = Poisson's ratio,
θ = temperature rise at any time t and depth x.

Equation (2) was derived on the assumption that the end effects of the drum only influence a small region surrounding them (St. Venants Principle).

By substituting the equations for θ in equation (2), the stress at any distance x from the rubbing path and at any time t can be determined and is given by

$$\sigma_t = \sigma_z = \frac{\alpha^{1/2}\,N\,E\,l}{K(1 - \nu)}\left[\frac{\alpha^{1/2}t}{d}\left(1 - \frac{Mt}{2}\right) - \frac{4\,t\,\alpha^{1/2}}{d}\,i^2\mathrm{erfc}\,\frac{d}{2(\alpha t)^{1/2}} + \frac{\alpha^{1/2}\,16\,Mt^2}{d}\,i^4\,\mathrm{erfc}\,\frac{d}{2(\alpha t)^{1/2}} - A\right] \quad (3)$$

where

$$A = 2\,t^{1/2}\left\{\mathrm{ierfc}\,\frac{x}{2(\alpha t)^{1/2}} + \mathrm{ierfc}\,\frac{2d - x}{2(\alpha t)^{1/2}}\right\} - 8\,M\,t^{3/2}\,i^3\mathrm{erfc}\,\frac{x}{2(\alpha t)^{1/2}}.$$

Variation of θ/N at different depths x/d inside a cast-iron drum for various times during brake application.

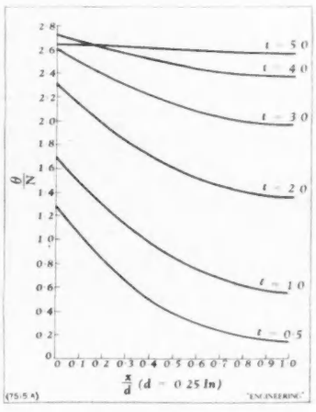


Fig. 1 5 sec. brake application. Drum thickness 0·25 in.

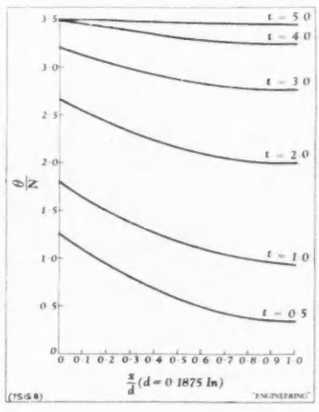


Fig. 2 5 sec. brake application. Drum thickness 0·1875 in.

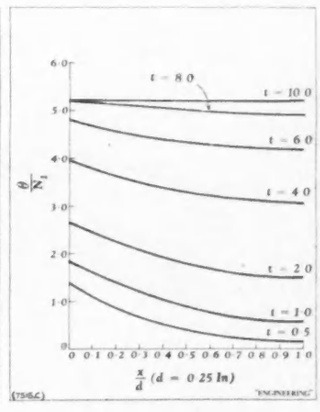


Fig. 3 10 sec. brake application. Drum thickness 0·25 in.

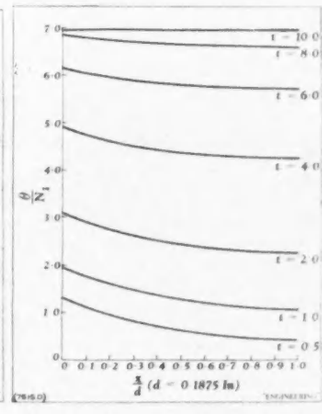


Fig. 4 10 sec. brake application. Drum thickness 0·1875 in.

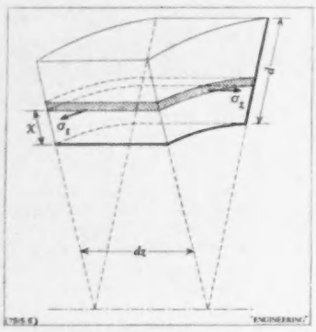


Fig. 5 Element of a brake drum.

for any time up to $t < 2s$ and

$$t = \sigma_z = \frac{\alpha \, NE \, l}{d \, K \, (1-\nu)} \left[\frac{d^2}{6\alpha}(1 - M\,t) - \frac{d^2}{2\alpha}(1 - M\,t)\left(1 - \frac{x}{d}\right)^2 - \frac{M\,d^4}{12\,\alpha^2}\left(1 - \frac{x}{d}\right)^2 + \frac{M\,d^4}{24\,\alpha^2}\left(1 - \frac{x}{d}\right)^4 + \frac{7}{360}\,\frac{M\,d^4}{\alpha^2} \right] \quad . \quad (4)$$

for $t \geqslant 2s$.

The function $i^n erfcz$ for various values of n and z is given in tabular form by Carslaw and Jaeger.[3]

Figs. 6, 7, 8 and 9 show the variation of stress with time at different depths x/d for the two brake drums considered previously when the time of a brake application is 5*s* and 10*s*. These curves indicate that both the maximum compressive and tensile stress are reached after 0·5*s* and 1·0*s* during a 5*s* and 10*s* application, respectively, when either brake drum is used. The maximum values for a 5*s* application are twice those for a 10*s* application when dissipating identical energies. Furthermore, the maximum stresses in a drum of thickness $\frac{3}{16}$ in are 0·75 those in a $\frac{1}{4}$ in drum. Fig. 10 shows the variation of the stress with x/d at different times during a 5*s* application and it can be seen that at $x = 0$ the maximum compressive stress is approximately twice the tensile stress at $x = d$, there being a neutral layer at $x = 0{\cdot}425d$.

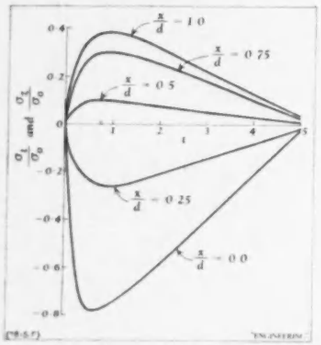


Fig. 6 5 sec. brake application. $d = 0{\cdot}25$ in.

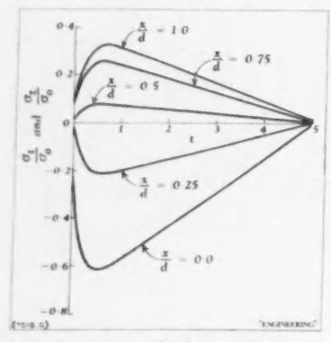


Fig. 7 5 sec. brake application. $d = 0{\cdot}1875$ in.

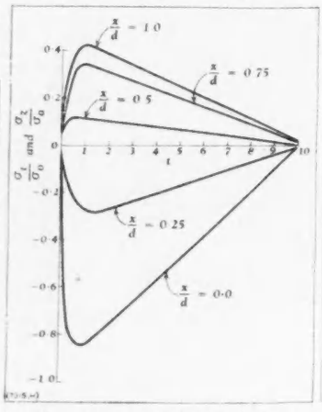


Fig. 8 10 sec. brake application. $d = 0{\cdot}25$ in.

In general, the stresses are smaller as the thickness of drum decreases since the thinner drum attains a uniform temperature more rapidly. However, the drum must not be made too thin as it will not be able to withstand the mechanical stresses and also it will not possess sufficient capacity to absorb the heat generated during continuous braking. It is advisable not to decrease the drum thickness below $\frac{3}{16}$ in for even low powered automobiles.

In a practical case, consider a car weighing 3,000 lb having a drum swept area of 84·8 sq. in with a drum thickness 0·25 in and made of cast iron where $E = 1{\cdot}8 \times 10^7$ lb per sq. in, $\nu = 0{\cdot}26$ and $l = 0{\cdot}0000055$ per ° F. If this car is braked from 60 m.p.h. to rest in ten seconds corresponding to a rate of deceleration $0{\cdot}27g$ which is higher than most normal applications (Carpenter[4]), then equation (3) shows that the maximum compressive stress in the front drum ($y = 0{\cdot}6$) is 5,381 lb per sq. in and the maximum tensile stress is approximately 2,659 lb per sq. in, both values well within permissible limits. The maximum temperature attained is 245° F. Thus, for normal driving with cars the bulk thermal stresses are well within permissible limits.

If the initial speed is 120 m.p.h. instead of 60 m.p.h. then for the same stopping time the maximum temperature attained is 940° F and the stresses are 21,524 lb per sq. in and 10,636 lb per sq. in for the maximum compressive and tensile stresses, respectively. If the temperature is sufficiently high the mechanical properties of cast iron are affected as shown in Fig. 11 and these changes must be taken into account. The change in tensile strength with temperature is taken from measurements made by Grant[5] for a short time tensile test on grey iron having a similar composition to that used in brake drums. The curve for E is based on results obtained at the University of Nottingham (private communication by Professor Pope). The compressive strength of cast iron is at least 2·0 to 2·5 times the tensile strength. Even at high temperatures the strength figures are much greater than those determined in a brake application from a high initial speed.

It appears, therefore, under heavy duty applications that the bulk stresses are unlikely to cause cracking or failure of the drum when uniform contact occurs between drum and lining. In some circumstances the contact occurs over small areas (hot spots) and in these regions if they are well dispersed, each spot can be considered as lying on the boundary of a semi-infinite solid. In this case the maximum compressive skin stress σ_s at the centre of a point source is given by the equation (see Timoshenko and Goodier[6])

$$\sigma_s = \frac{E\,l\,\theta_s}{(1-\nu)} \quad . \quad . \quad . \quad . \quad (5)$$

where θ_s is the local temperature at the centre of a hot spot. If $\theta_s = 1{,}000$° F the value of σ_s is 133,800 lb per sq. in and local plastic yielding around the region of a hot spot may occur.

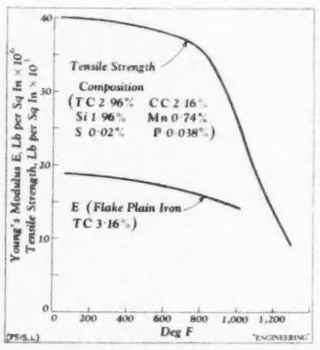

Tensile Strength
Composition
(TC 2·96% CC 2·16%
Si 1·96% Mn 0·74%
S 0·02% P 0·038%)
E (Flake Plain Iron
TC 3·16%)
Young's Modulus E, Lb per Sq In × 10⁶
Tensile Strength, Lb per Sq In × 10³
Deg F

Fig. 11 Physical properties of a typical grey cast iron at elevated temperatures.

The above analysis assumes that the composition of the drum is unchanged by high temperatures and gradients whereas Toghill and Angus[7] and Angus and Lamb[8] state that metallurgical transformations can occur in braking. Presumably, cracking can also be associated with such changes, for example, if martensite should form from pearlite its lower density and greater volume will introduce stresses on the surface of the drum giving rise to failure.

CONCLUSIONS

(i) The temperature gradient and thermal stresses at any depth inside a brake drum depend on the thickness of the drum and duration of the brake application. Increasing the drum thickness raises the thermal stresses, for example the maximum values for a $\frac{1}{4}$ in thick drum is approximately 1·25 times that of a $\frac{3}{16}$ in drum. The longer the application the smaller the stresses.

(ii) The maximum compressive stress developed is approximately twice the maximum tensile stress.

(iii) The neutral axis of a brake drum is at a distance 0·425 times the drum thickness away from the rubbing path.

(iv) In heavy duty brake applications if contact between drum and lining is uniform the thermal stresses do not exceed the ultimate strength values for the material even if allowance is made for the decrease in strength properties at higher temperature.

(v) The stresses around hot spots are very high and are sufficient to cause thermal cracking.

Acknowledgements.—The author wishes to thank Dr. R. T. Spurr and Mr. A. Stinton of the Research Division of Ferodo Limited for assistance and criticism, and the directors of Ferodo Limited for permission to publish this paper.

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References continue.l overleaf

Variation of $\frac{\sigma_t}{\sigma_0}$ and $\frac{\sigma_z}{\sigma_0}$ $\left(\sigma_0 = \frac{NEl}{1-\nu}\right)$ with time for various depths x/d.

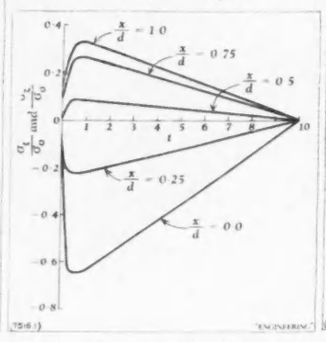

Fig. 9 10 sec. brake application. $d = 0{\cdot}1875$ in.

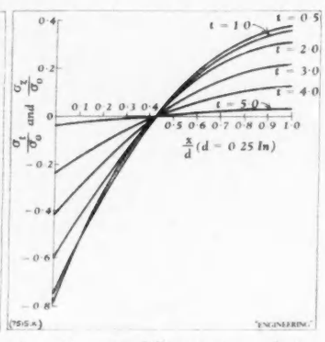

Fig. 10 At different times during 5 sec. brake application.

First Microwave Transistor Amplifier

A new germanium mesa transistor, which operates for the first time in the microwave frequency region, and a very wide band amplifier employing this transistor, have recently been developed at the Bell Telephone Laboratories, USA. In order to achieve such high frequency operation, the dimensions of the new transistor have been cut down so that the total area of the active region is " less than the cross-section of a human hair." The amplifier employs transmission-line construction, consistent with the transistor encapsulation.

The device is a diffused-base, alloy emitter, p-n-p mesa transistor, designed for use as an oscillator at 3,000 Mc/s, or as an amplifier at 1,000 Mc/s and below. The mesa (plateau) is

A microwave amplifier, having excellent stability characteristics and a low noise factor, has been made for the first time with mesa transistors.

said to be $1.8.10^{-3}$ in long, and $1.5.10^{-3}$ in wide. Three metal strips, each $0.3.10^{-3}$ in wide, are evaporated on to the surface of the mesa and alloyed into the semiconductor. Gold wire, two tenths of a " thou " in diameter, are used to make the connections.

Since conventional encapsulation methods for transistors introduce a certain amount of parasitic capacitance and inductance, this device is mounted in a coaxial shell which electrically matches a 50 ohm coaxial transmission line. This enables the full frequency capabilities of the device to be realised.

A three-stage amplifier has been made, using the transmission-line principle, in which the gain was said to be flat within 1 dB over the frequency range 1 to 750 Mc/s. Although the gain of this amplifier was low, a higher gain could have been achieved at the expense of bandwidth. The amplifiers made so far are said to have shown excellent stability and noise figures of the order of 5·5 dB at 200 Mc/s, without feedback.

High Temperature Thermal Conductivity

As part of a broad research programme concerned with the properties of materials at high temperatures, the US National Bureau of Standards has been studying methods for measuring thermal conductivities. A new method for determining thermal conductivity by a steady-state comparative method has been developed, applicable to homogeneous materials of low to moderate conductivity in the form of flat slabs or hollow cylinders. A comprehensive analysis of the method as applied to flat slabs has been made.

A small apparatus based on the new method has been built to measure the thermal conductivity of explosives and solid propellents for rockets. A larger apparatus for experimental purposes is being built for materials that can be used in the temperature range −195° C to +1,200° C. This equipment will replace three separate sets that are currently in use at the bureau, and which between them cover the range −170° C to +750° C.

Potential advantages of the new method include the possibility of supplying practically identical replicate systems to other laboratories to promote uniformity of thermal conductivity measurements made at different centres.

Underwater Corrosion Between Adjacent Ships

After two destroyers of the Royal Australian Navy had been berthed alongside each other on a number of occasions it was found that severe underwater corrosion had occurred on one of them. They had been connected to each other by steel ropes and one of the ships had not been cathodically protected whereas the other had. Tests were carried out to determine the degree of electrical bonding required to reduce this corrosion to negligible proportions and to establish whether the corrosion that had occurred was due to ineffective bonding.

It was decided from these tests that serious corrosion of an unprotected hull berthed alongside one which is cathodically protected can be avoided by electrically connecting the hulls so that the resistance between them is less than 0·0005 ohms. This can be done by using two 200A cables in parallel, secured to brass studs brazed to the deck plates. The hull to hull resistance of steel berthing ropes and of the bonds normally used in the d.c. welding of ships, are well in excess of 0·0005 ohms. Investigations left little doubt that the corrosion was due to the frequent adjacent berthing of the two ships.

This information appeared in an article entitled " Electrical Bonding of Cathodically Protected to Unprotected Ships," by G. A. Bennett, N. S. Dempster and A. J. Wallace in *Corrosion*, p. 587, Vol. 15, USA, 1959. It was also abstracted in the *Journal of the British Shipbuilding Research Association*, Vol. 15, January, 1960.

Magnetohydrodynamics Research Report

Recent studies in electrical phenomena may play a significant role in space propulsion, controlled thermonuclear reactions and supersonic flight, according to an article published by the Battelle Memorial Institute, Ohio, USA. Published under the title " Magnetohydrodynamics " in the *Battelle Technical Review*, the article mainly discusses research on the interaction between magnetic fields and electrically conducting gases, and the significance of this research on space technology.

When a magnet moves through an electrically conducting gas, it causes flow patterns to be set up in the gas. Knowledge of these effects can be turned to practical advantage, writes the Battelle research worker. For example, installation of magnetic equipment in a re-entry satellite can produce additional drag, thus conveniently slowing down the vehicle at high altitudes.

Magnetohydrodynamic effects also increase the distance between a rapidly moving body and the shock wave which precedes it. This extra space allows room for greater heat dissipation, and therefore lowers the temperature of the body's surface. However, research indicates at the moment that the extra weight of the magnetic equipment is too much to warrant its use for heat reduction.

In addition to producing braking effects, magnetohydrodynamics can be used to produce lift forces without the need for lifting surfaces such as wings or fins. This offers the possibility of controlling and modifying the trajectories of space vehicles when entering planetary atmospheres.

Another suggestion arising from the research carried out at Battelle is the use of the electrical energy generated in the shock layer preceding a high speed (supersonic) aeronautical body to operate equipment within the craft. This electrical energy is present in an ionised gas plasma which exists in the shock layer.

Nuclear-Powered Weather Station

The possibility of powering remote weather stations with a nuclear thermoelectric generator has been proposed by the Nuclear Division of the Martin company, Baltimore, Maryland, USA. A small cylinder, shown arrowed, inside the cutaway cylinder in the illustration, would contain about a pound of radioactive material surrounded by thermoelectric elements. This would convert heat directly into electrical energy which would then be used to power the measuring instruments and the radio transmitter.

Having no moving parts, the thermoelectric generator would be capable of powering an automatic meteorological station, without attendance, for about two years. Strontium 90, locked safely within a stable insoluble compound

Artist's impression of an automatically-operated weather station, which could work without attention for two years by using a nuclear thermoelectric power source.

at the core of the generator, would generate heat through spontaneous decay. Seventy-two thermocouples surrounding the fuel capsule would then turn the heat directly into electrical energy. The output power would be about 5W.

Although the generator has been designed primarily for use on land, it is believed that it could survive immersion in sea water for several years without releasing its radioactive fuel.

Concluding **Thermal Stress**

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At Home

Garden Labour

It was only to be expected that plastics would make their way into the garden sooner or later. They have been more and more used for the handles of engineers' tools as well as for the more mundane purposes of cover plates and grass boxes and now they have reached spades and forks.

The Bulldog range of garden spades and forks have a light steel shaft covered with a plastics sheath and fitted with a plastics handle. Lightness coupled with strength and smoothness are the chief claims. As a final touch the handle can be in a different colour from the shaft to give an artistic effect. The material used for sheathing the shaft is high density polyethylene and the handle is made in high acetyl cellulose acetate.

In spite of the reduction in weight that this

The Tool Kaddy enables the gardener to take all the tools needed in one journey.

offers, garden tools are rather lumpy items to carry any distance. For the larger garden, therefore, the Tool Kaddy has been produced by Edward Elwell. It is shown in the first illustration. The Kaddy has a base area of 1 ft by 1 ft so reducing the room required for tool storage. The basic kit that it will take is made up of a spade, large fork, border fork, rake, scuffle hoe, long handle weed fork, hand trowel, and hand weed fork. In fact, all the tools normally required for 90 per cent of all garden jobs.

Apart from the tools, which are held in place by spring clips, the Kaddy has a scraper blade fixed to the base for removing mud from the boots. Recesses are provided for the lower ends of the tools to prevent them coming loose during transport. One very real advantage is that all the tools can be transported at once and tedious coming and going to fetch forgotten items is eliminated.

The Simcett range of garden furniture also includes two four-wheeled trolleys for the carriage of tools and general garden gear. One of these, the Toolmobile, has a steel body with racks at the side for long handled tools. The body is 36 in long and runs on 11 in diameter rubber-tyred wheels. The second is the Loadmobile which has a wooden body and drop tailboard. It is 30 in long and runs on similar wheels.

Lawn mowing is one of the more strenuous jobs that many gardeners have to face, especially if the lawn is any size. Power driven mowers take out much of the hard work, particularly if they have the roller driven as well as the blades. Claimed to be the cheapest fully driven 14 in mower yet on the market is the Ransomes Sprite now making its appearance. It is also claimed to be the lightest. Power is supplied by a two stroke JAP engine of 34 c.c. capacity, described as docile and easy to start. Controls consist of a clutch and a throttle mounted on the continuous handle bar which is U shaped.

The frame of the machine is a steel pressing which completely encloses the drives. Attention has been paid to a smooth outer form to avoid trapping grass cuttings, and to enable the machine to cut close to obstructions. Open edges can be cut.

The drive is taken from the engine through the Glida-Mo clutch by a V belt to the roller and then by chain to the blades. The belt affords protection to the blades and the drive as it will slip if the blades meet an obstruction. There are five cutting blades, a single drive roll at the back and twin rolls at the front. The weight complete with grass box is 75 lb.

But even the best of these power driven mowers requires that some unfortunate should walk behind it and occasionally twitch it round corners. In this sedentary age such occupation is counted laborious and the natural result is the radio-controlled mower, a prototype of which made its appearance at Chelsea last year. Developed by H. C. Webb, who make petrol and electrically driven mowers, the radio-controlled machine is operated by two buttons only. It has a 14 in cut with the drive taken to the centre of the blades, and progresses at 1·82 m.p.h. To give a smooth ride over undulations it has independent four corner suspension. The $\frac{1}{3}$ h.p. motor is powered by a 24 volt battery and runs at 1,450 r.p.m. On the mower is a multistage receiver operating at 27 Mc/s which receives commands from the transmitter. The latter measures $9\frac{3}{4}$ in by $6\frac{1}{2}$ in by 3 in and houses the two control switches already mentioned. But even this machine requires that the operator keep awake—perhaps the next development will be one that will steer itself, turning automatically

Real luxury in lawn mowing is achieved by the Webb radio-controlled machine.

when it reaches the edge of the lawn. Theoretically it is not impossible; economically, perhaps it is.

Alas, no mower will also trim the edges of the lawn. This job yet remains to be done by hand. Still, clippers have been made with long handles to remove the need for stooping, or there is the Jalo Roto-Edger which offers continuous operation. It consists of two rubber-tyred rollers mounted in a frame at the end of a long handle, with on one side a rotating cutter made up of several blades moving against a fixed blade. This cutter projects below the level of the rollers so that it will make a clean square cut along the edge of the turf while the operator merely walks along pushing it. It can be used in either direction to cut right or left hand edges.

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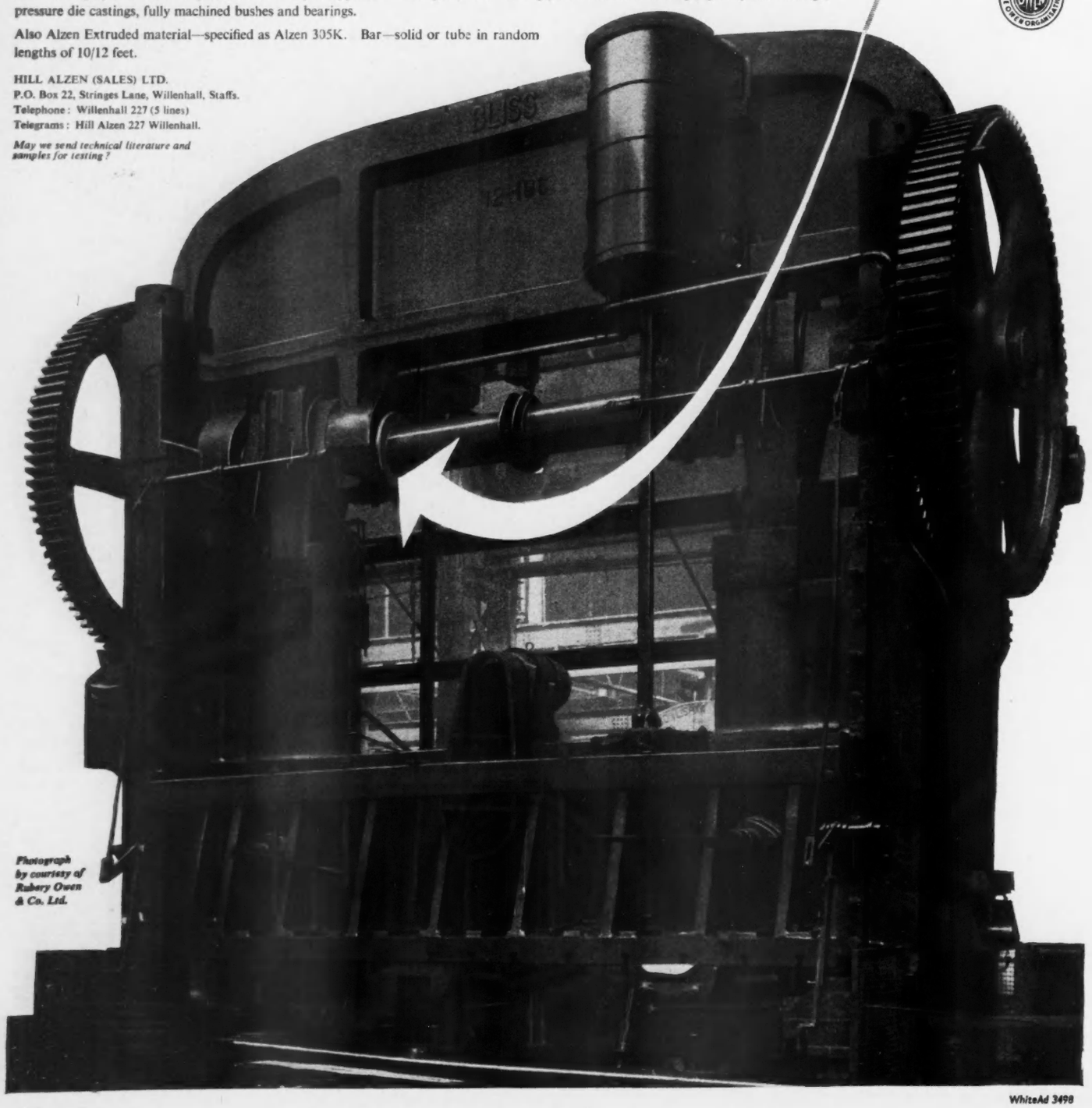

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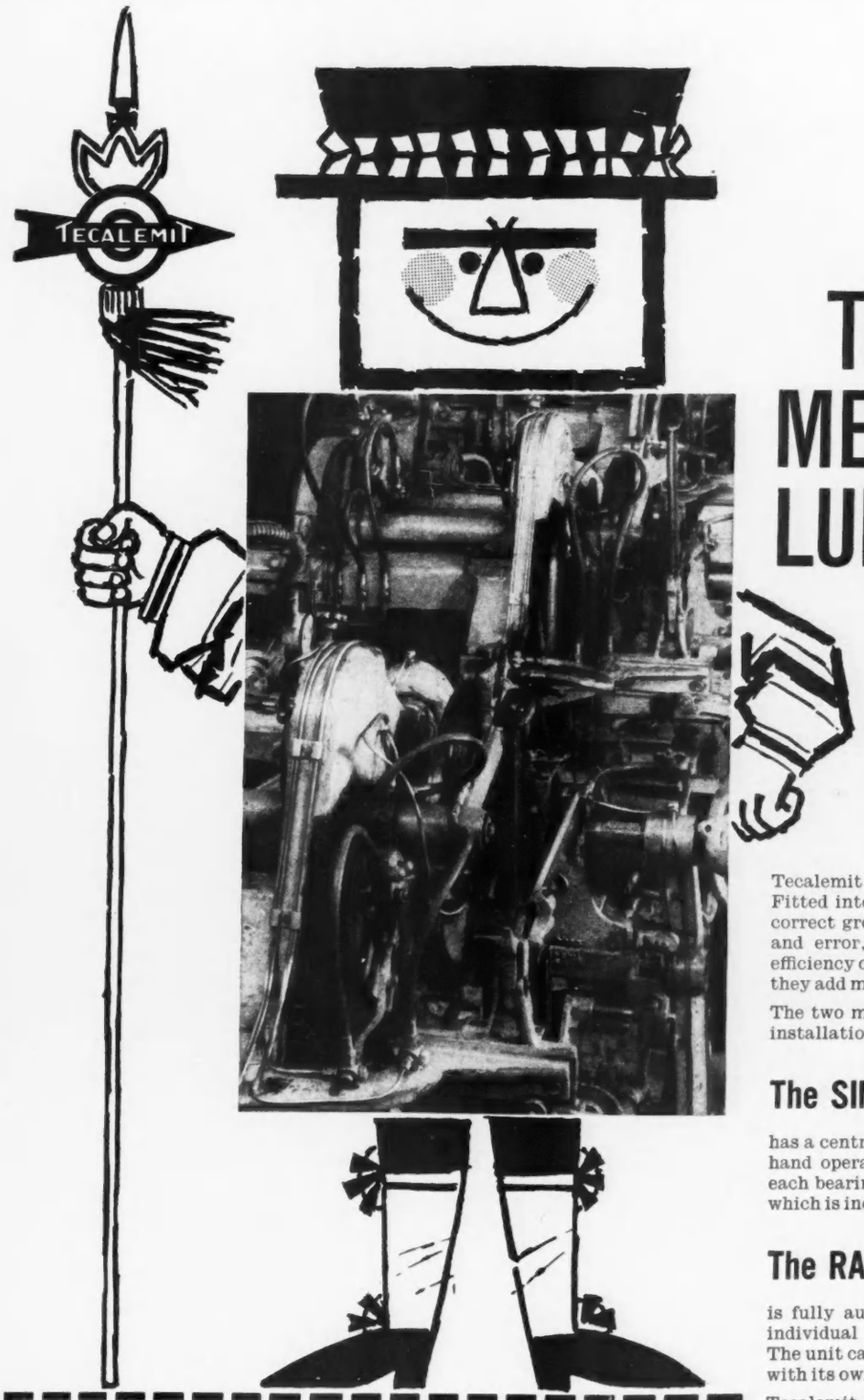

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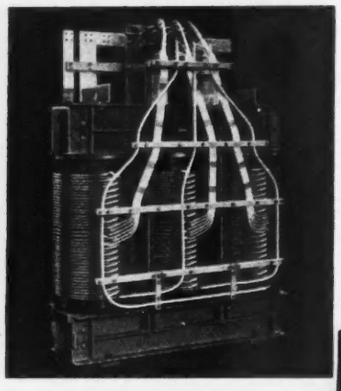

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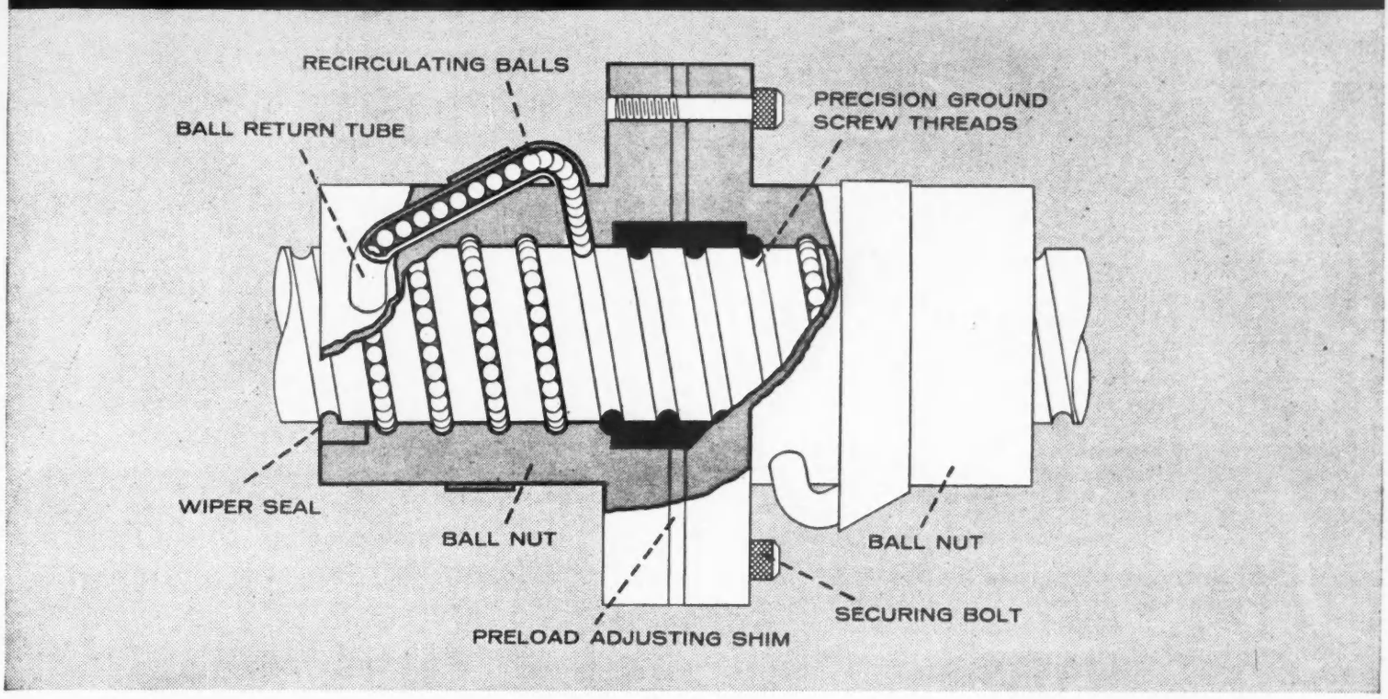

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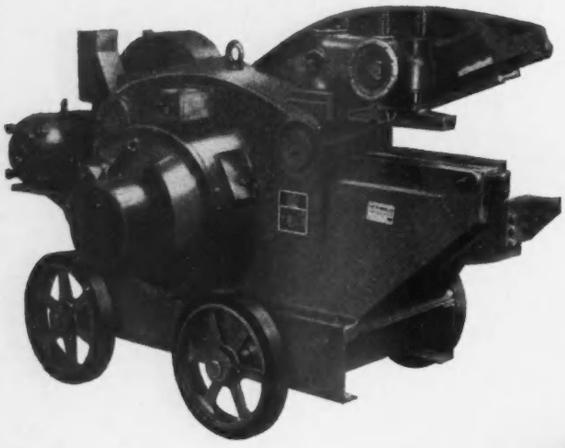

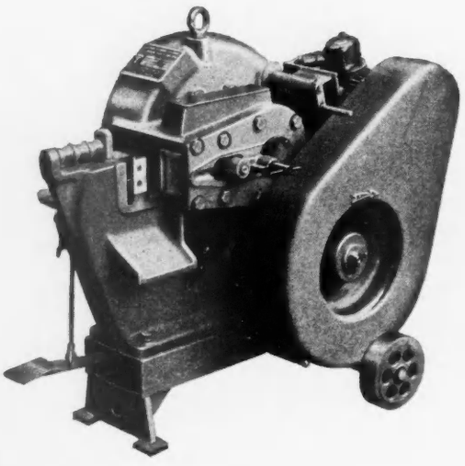

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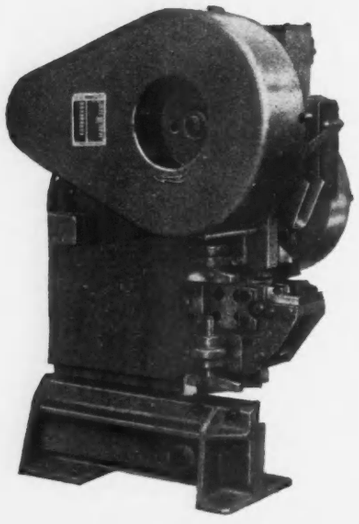

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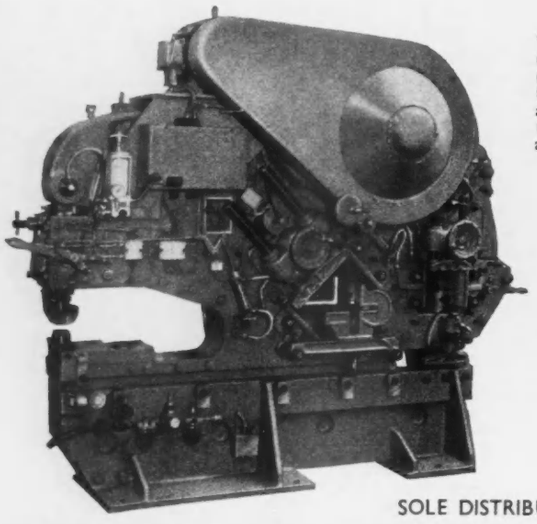

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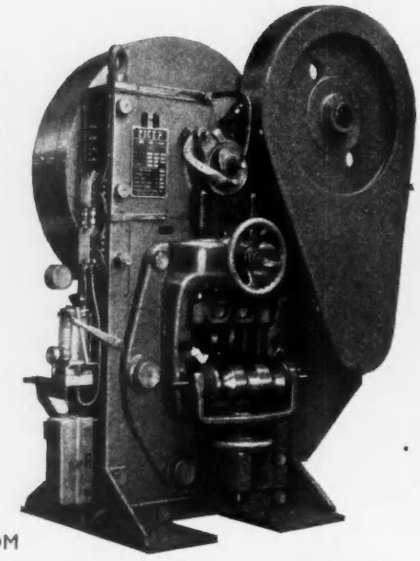

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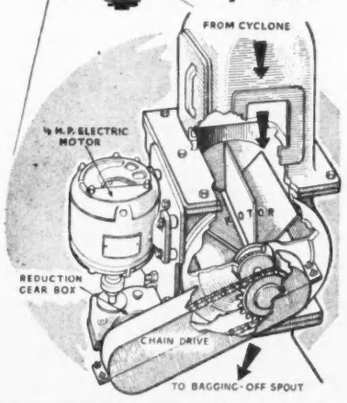

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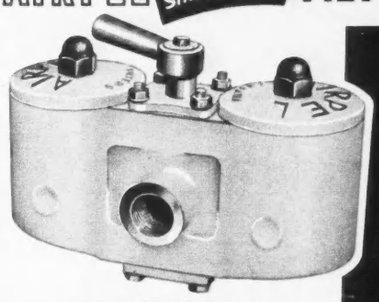

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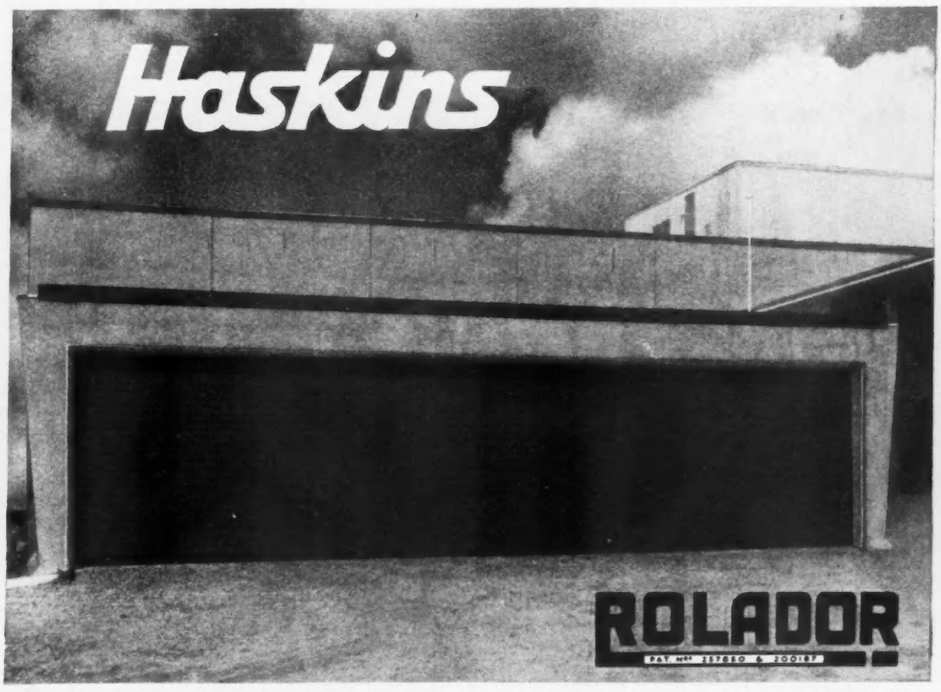

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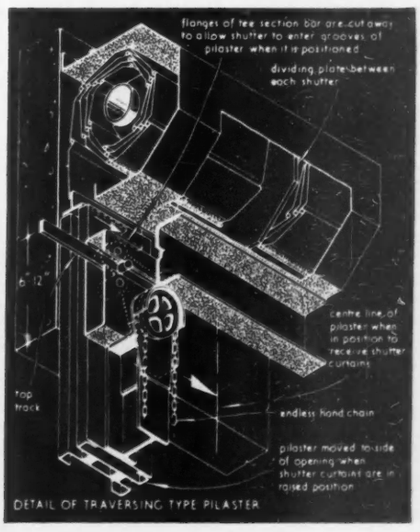
flanges of tee section bar are cut away to allow shutter to enter grooves of pilaster when it is positioned
dividing plate between each shutter
6" 12"
centre line of pilaster when in position to receive shutter curtains
top track
endless hand chain
pilaster moved to side of opening when shutter curtains are in raised position
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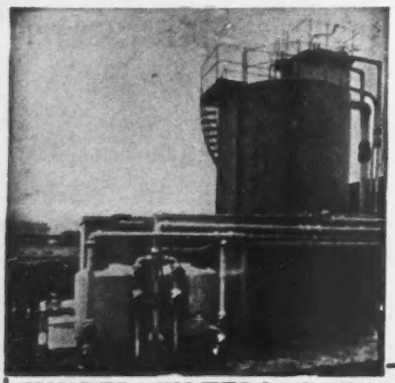

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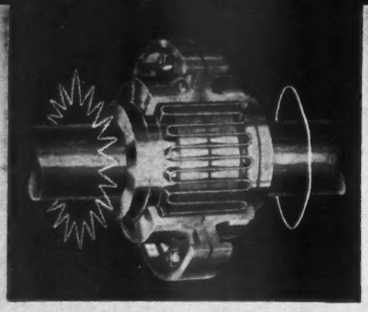

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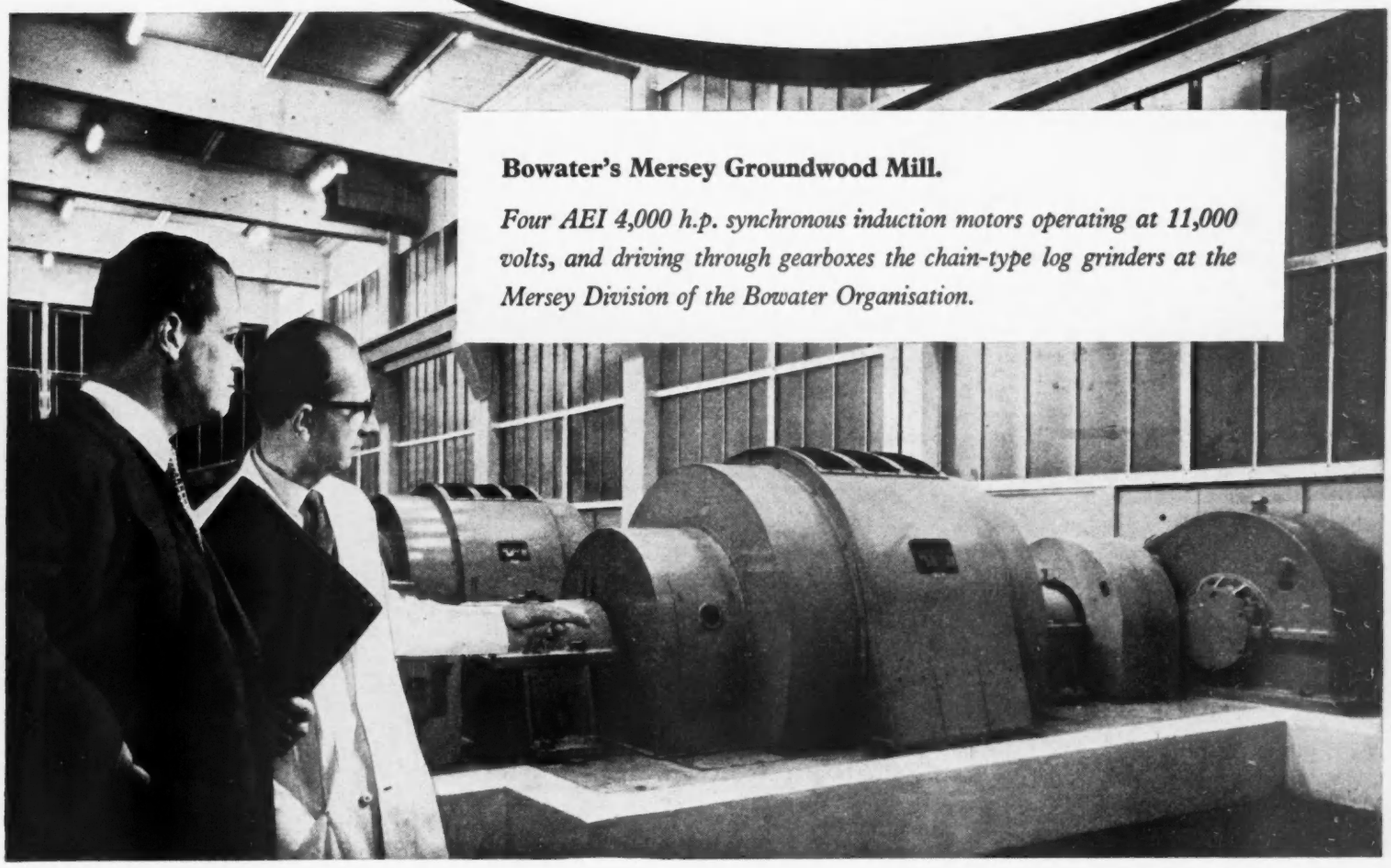

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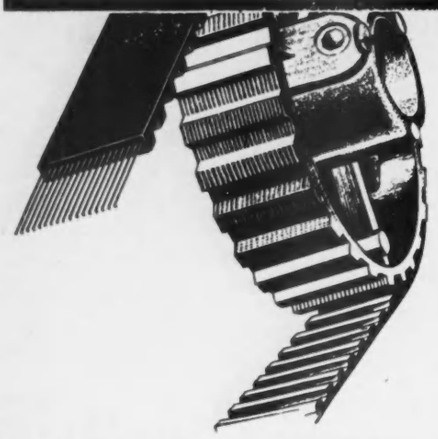

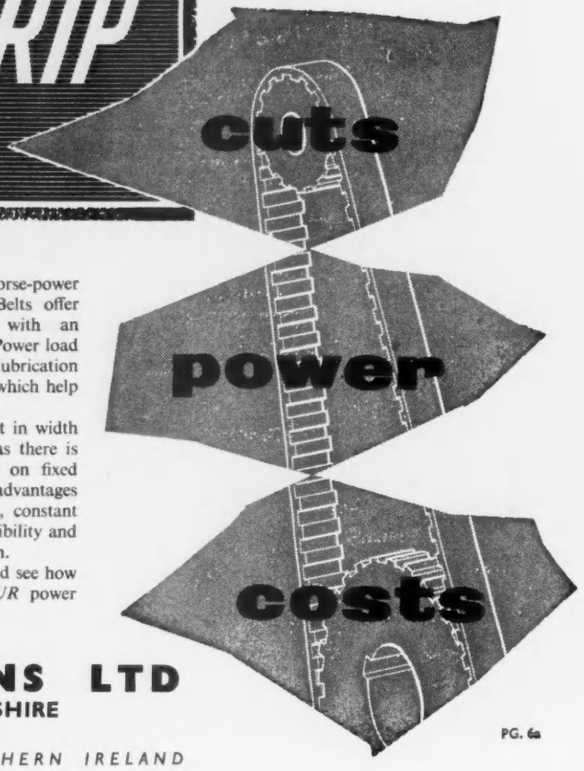

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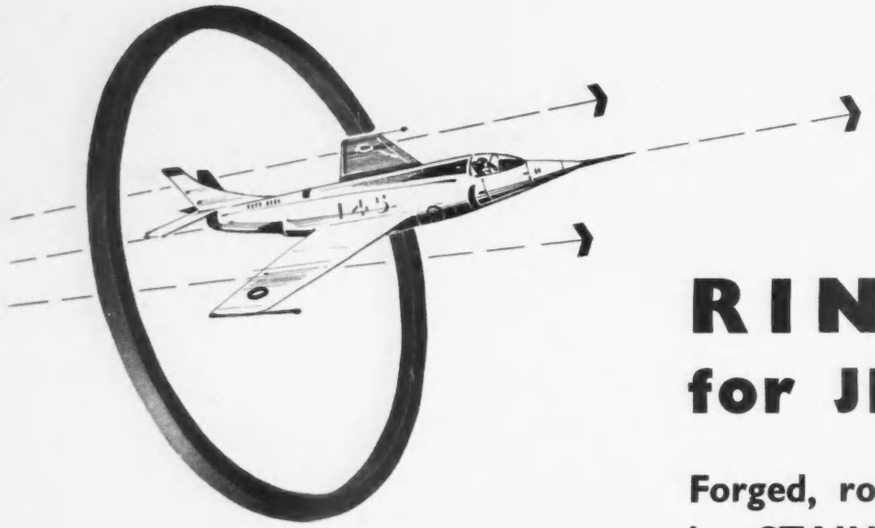

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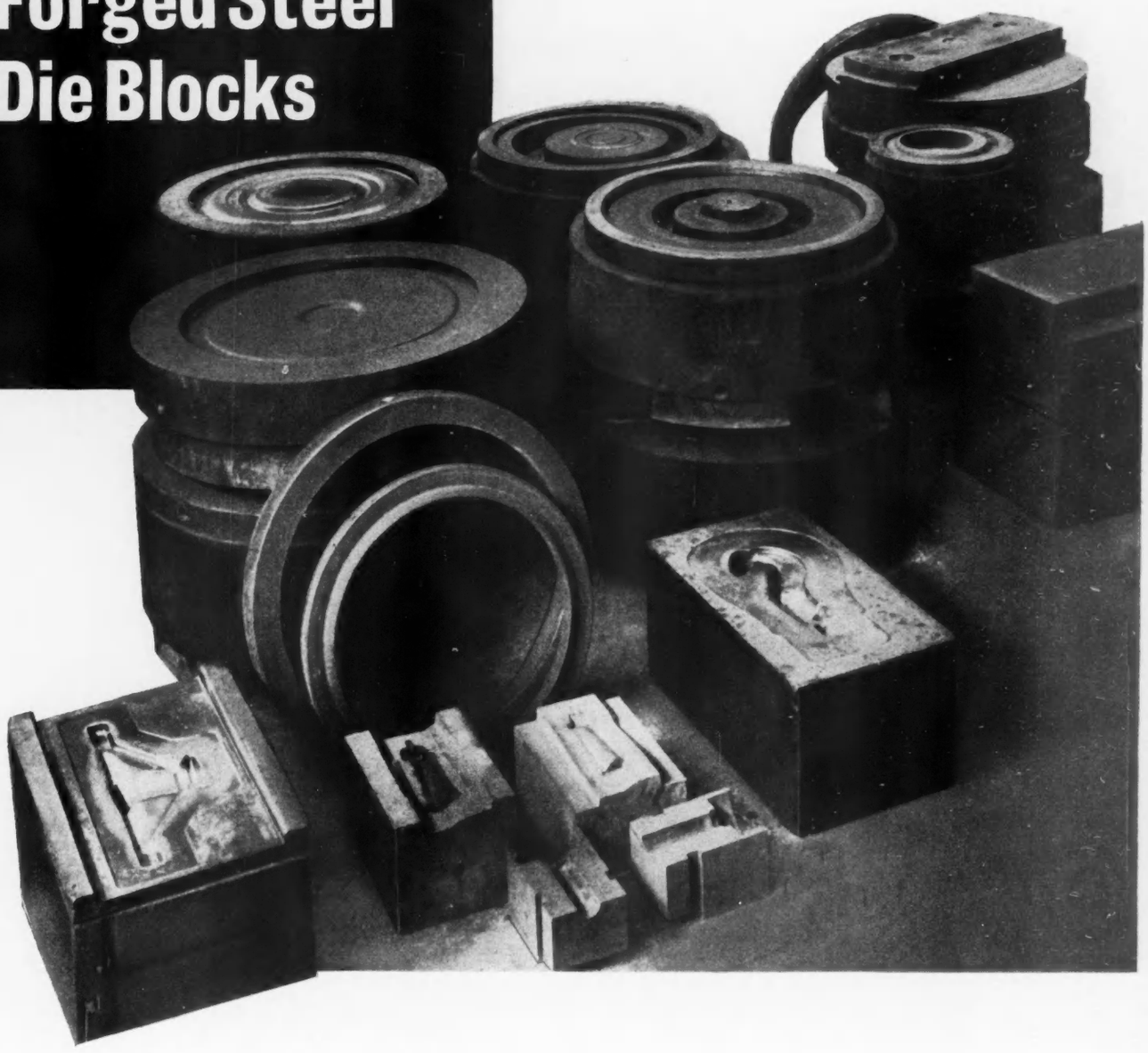

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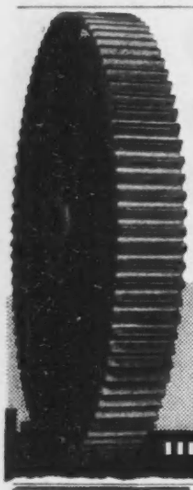

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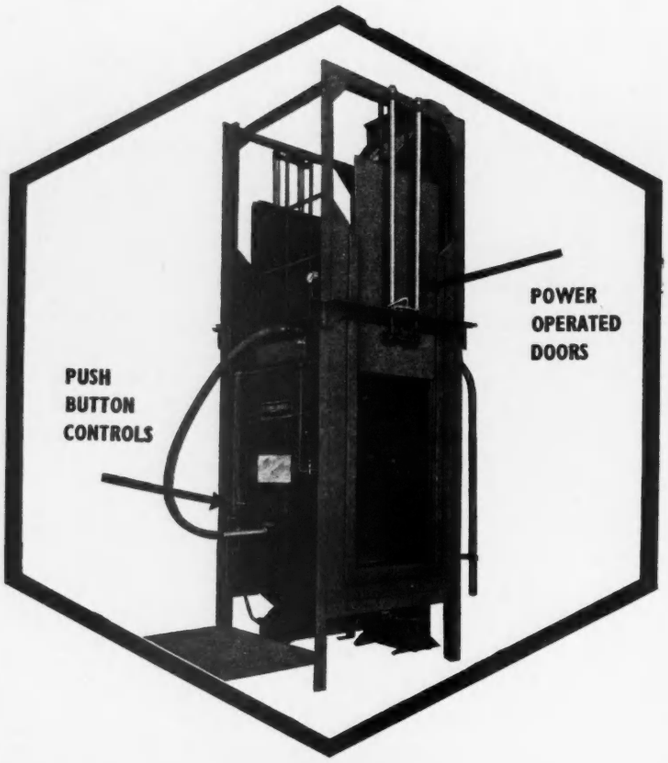

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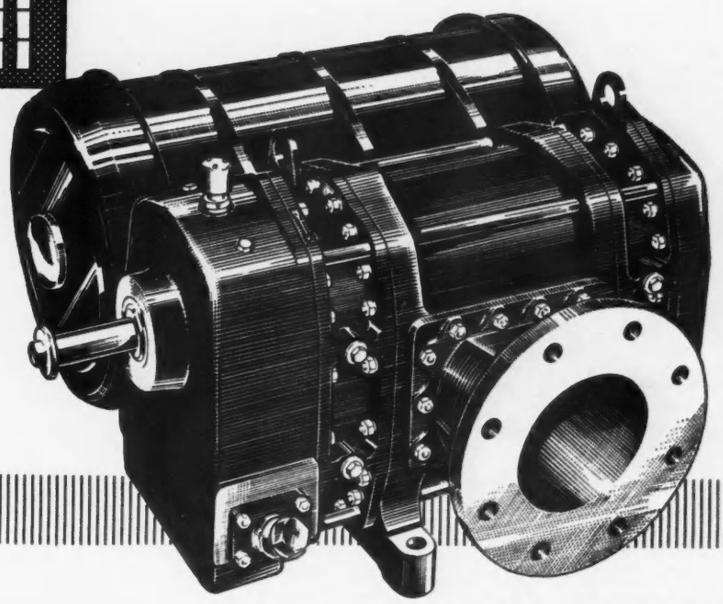

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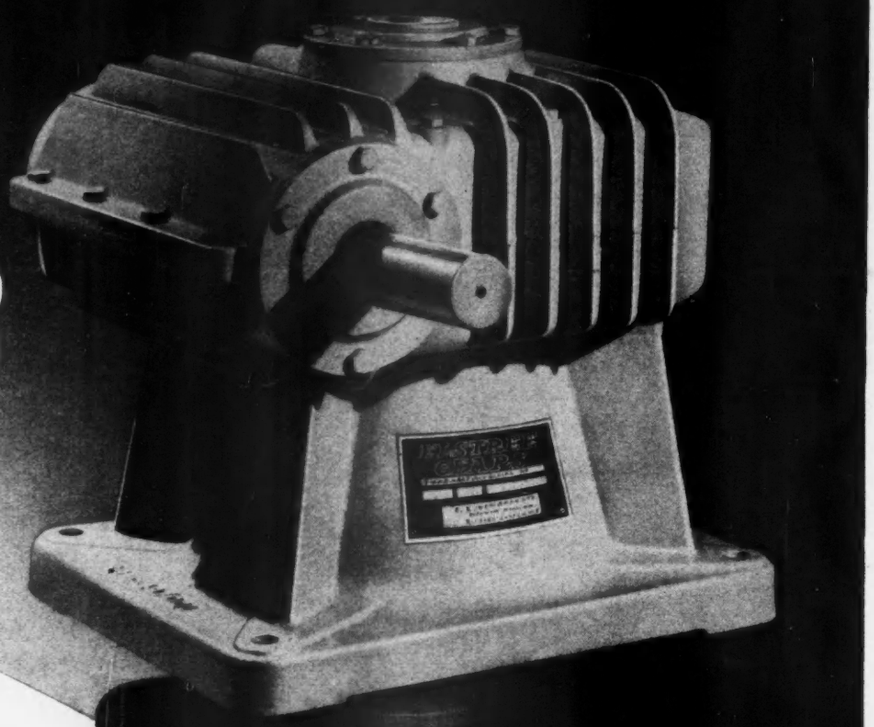

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The Worm Reduction Gear Box illustrated has been specially designed for liquid agitation. Features of this Box are wide spacing between bearings to allow for long unsupported impeller shafts and a bottom bearing specially designed to prevent oil seepage down the shaft. Further details on request.

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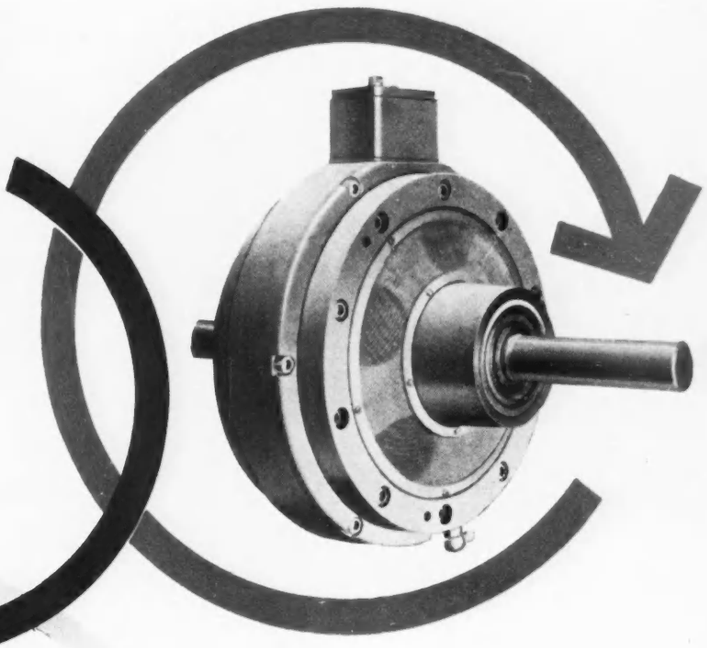

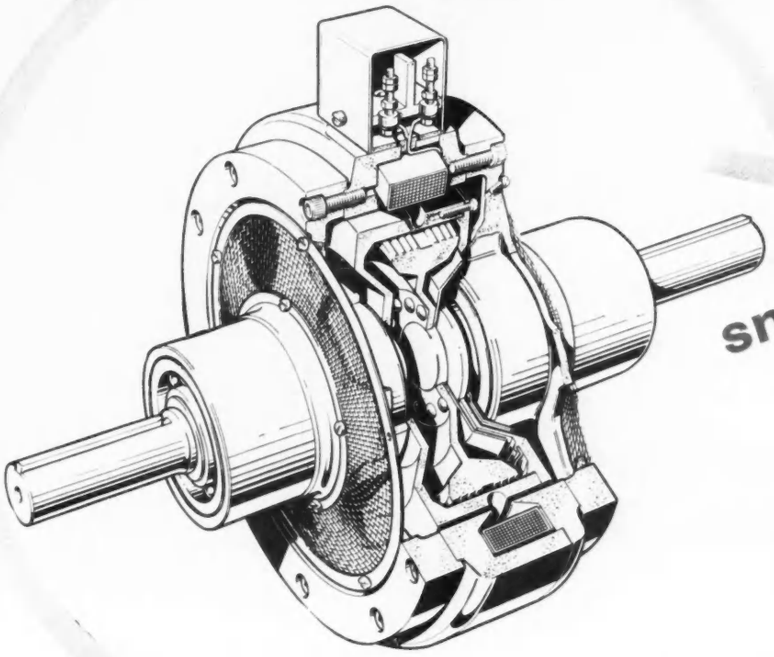

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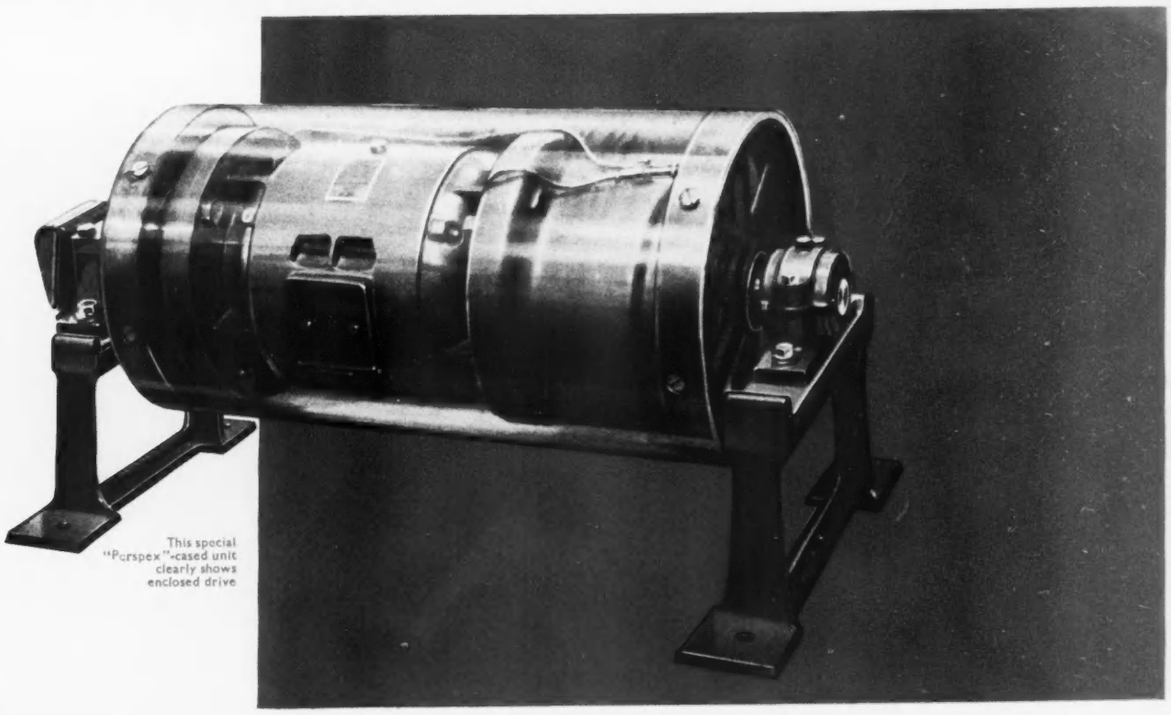
Incidentally, South Durham have also supplied over 5,000 tons of their "Rendhex" Steel Hexagon Foundation Columns in special lengths for the deep-water foundations to the tanker jetty at Angle Bay.



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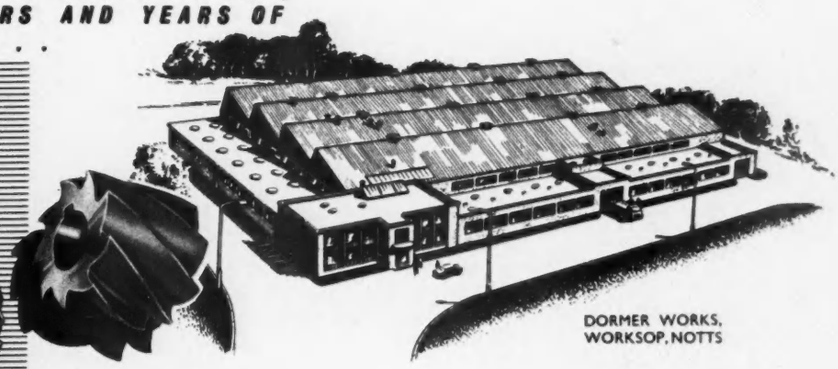

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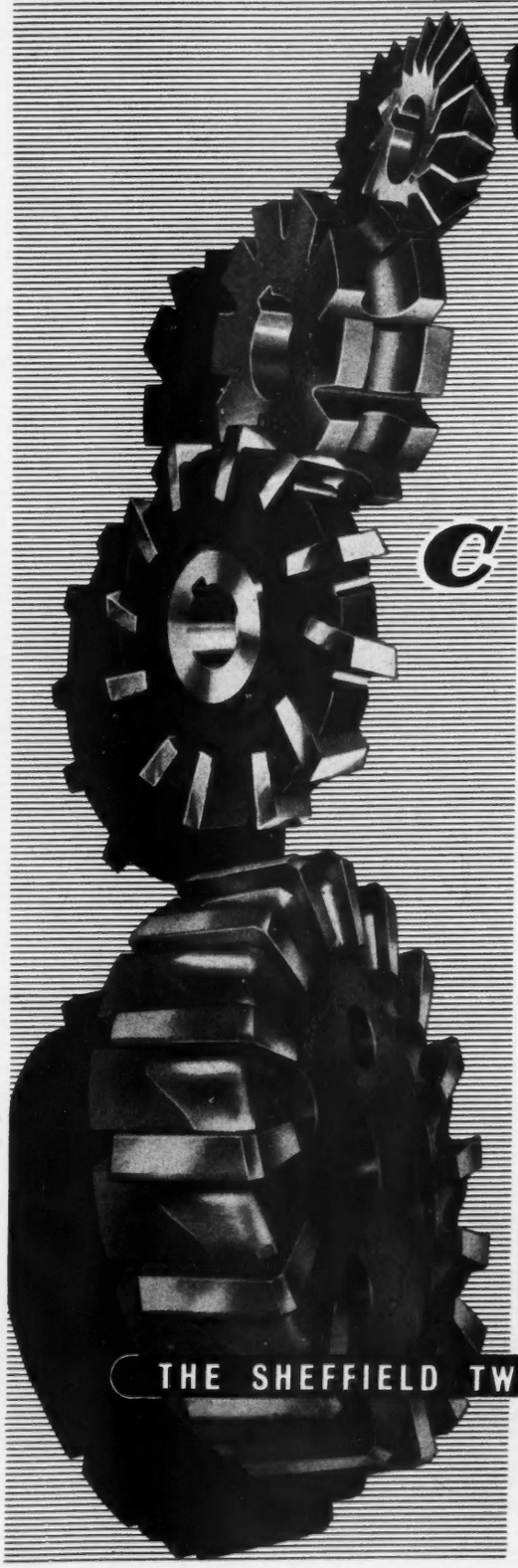

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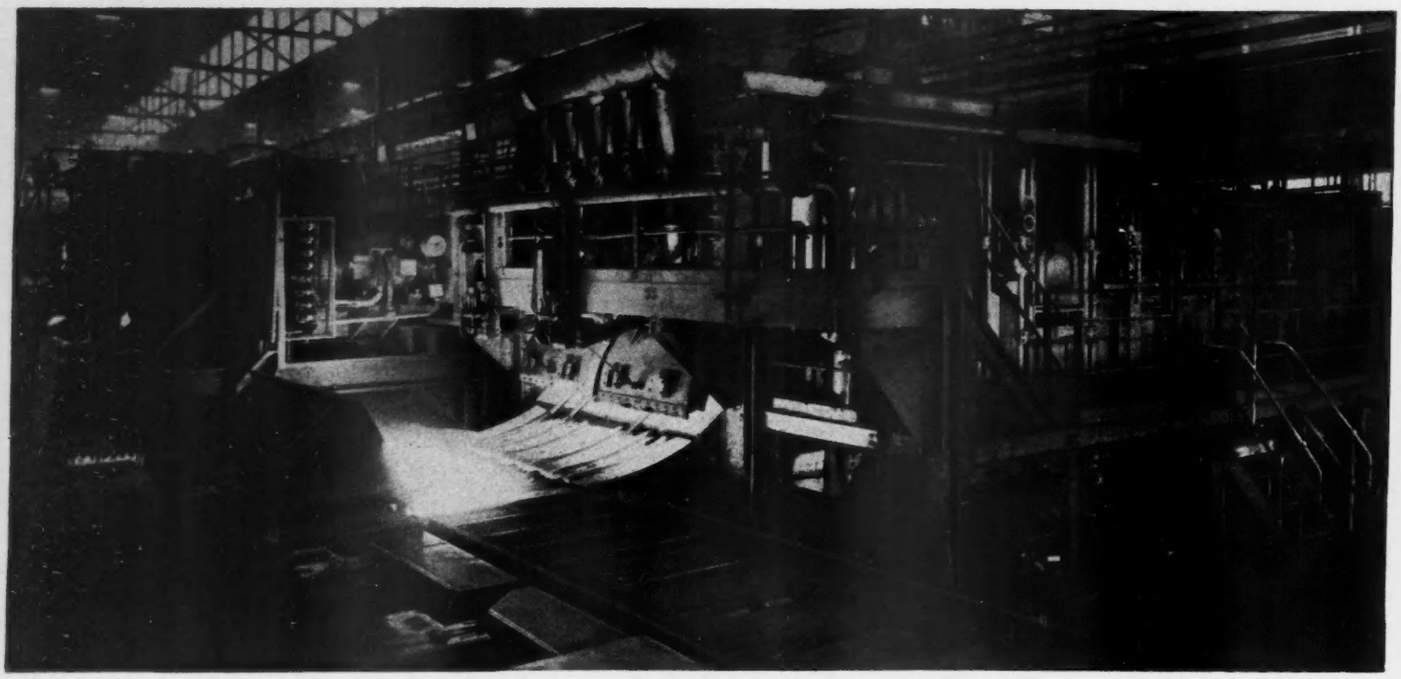

Fig. 1. A hot slab being ejected from the furnace on to the roller table.

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Stainless Steel—a British discovery by Brearley in Sheffield in 1913, overcame the atavistic tendency of ordinary steels to return to iron oxide as rust.

Now highly polished Stainless Steel adds glamour to kitchens and hotel, office and shop fittings. Perhaps more important, its resistance to corrosion offers a hygienic surface to the food manufacturing industries, large scale caterers and for hospital equipment, including sterilisers and the surgeon's delicate instruments.

This glamour applies not only to Stainless Steel products, some of which are illustrated in this article, but also to its processing. In fact, the ultimate durability of Stainless Steel depends upon a precise temperature/time heating and reheating schedule, which processes are usually carried out by town gas because of its inherent flexibility as a heating medium.

Fig. 1 shows a close-up view of a slab heating furnace at Shepcote Lane Rolling Mills Limited—a subsidiary company of Firth-Vickers Stainless Steels Limited, in which Samuel Fox & Co. Limited have a one-third interest. In the illustration a red hot slab has just been ejected on to the run-out table. This furnace heats nine tons of slab hourly at a temperature of 1,230°C before ejection, using 35,000 cubic feet of town gas per hour—each slab weighing approximately three tons.

The impressive machinery used to process Stainless Steel is shown in Fig. 2—the plant producing either matt or mirror-finished coiled strip. In the background are shown the gas-fired slab-heating furnace and the primary rolling section. The gas-fired coil reheating furnaces and the automatically controlled four-high finishing mill together with the run-out table are shown in the foreground.

Fig. 2. A general view of the hot mill bay showing furnaces, Steckel Mill and run-out table.

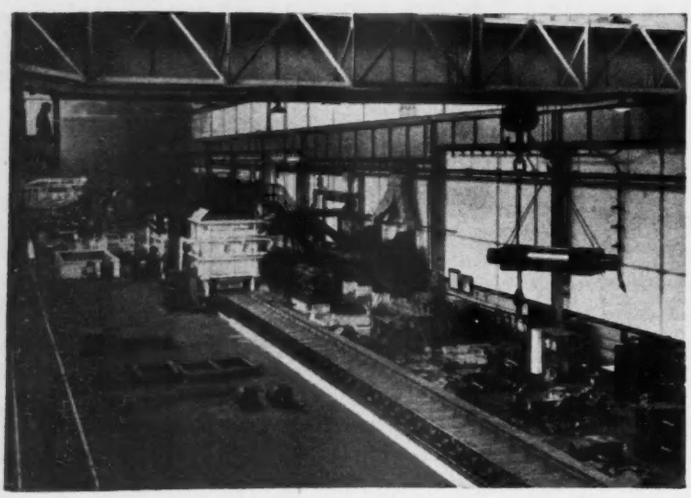

Fig. 3. The four-high hot Steckel Mill installed at Shepcote Lane Rolling Mills Limited.

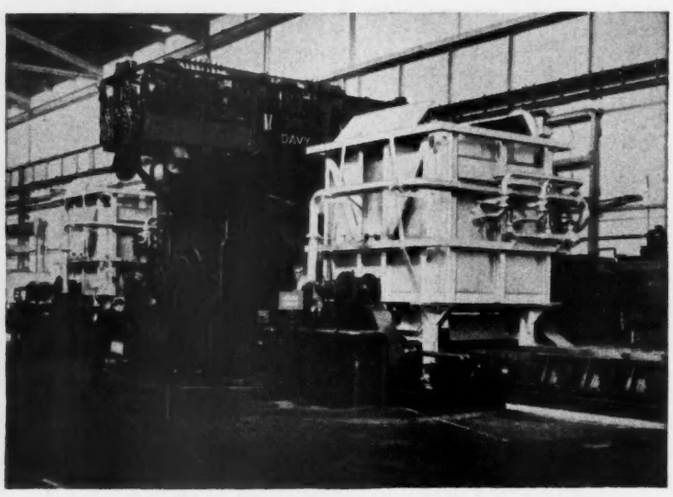

Fig. 3 shows the complex four-high Steckel Mill with its adjacent coil reheating furnaces. Each furnace is rated at 8,000 cubic feet per hour, and the plant will roll up to nine passes with a drop in temperature of the steel of only 250°C.

The treatment of Stainless Steel is only one of thousands of different trades, professions and processes served by the Gas Industry. Each Area Gas Board has specialist staff familiar with the heating problems of these many industries. They all pool their ever-increasing knowledge through the Gas Council's Industrial Gas Development Committee, whilst the Industrial Gas Information Bureau keeps in touch with developments in gas-fired equipment in all parts of the world. Thus any user, or potential user, of gas-fired equipment has a fund of technical knowledge available to him by asking for the services of his Area Gas Board.

Fig. 4. A sterilising unit for surgical and dental instruments.

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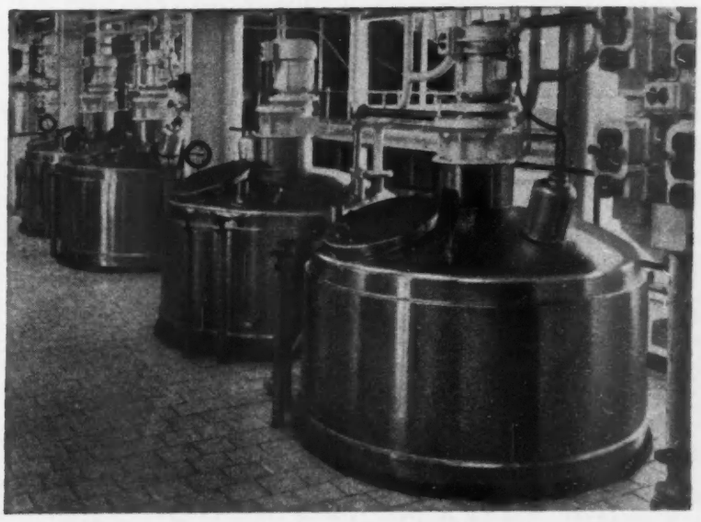

Fig. 5. Receiving and storage tanks for margarine blends in the processing department of Van Den Berghs & Jurgens Ltd., Stork Margarine Works, Purfleet.

Fig. 6. The Wimpy, Lyon's Corner House, Coventry Street, London.

Fig. 7. The largest stainless steel carpet dyeing machine ever produced in Great Britain.

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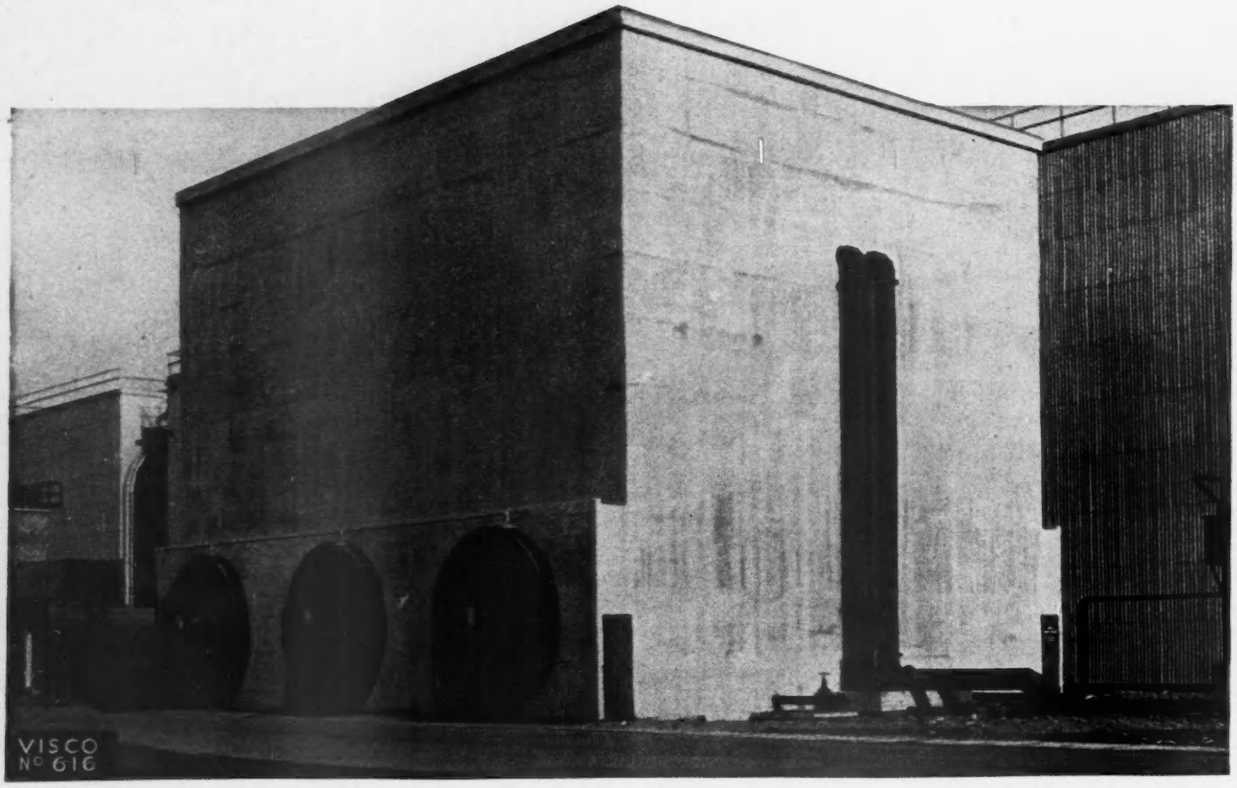

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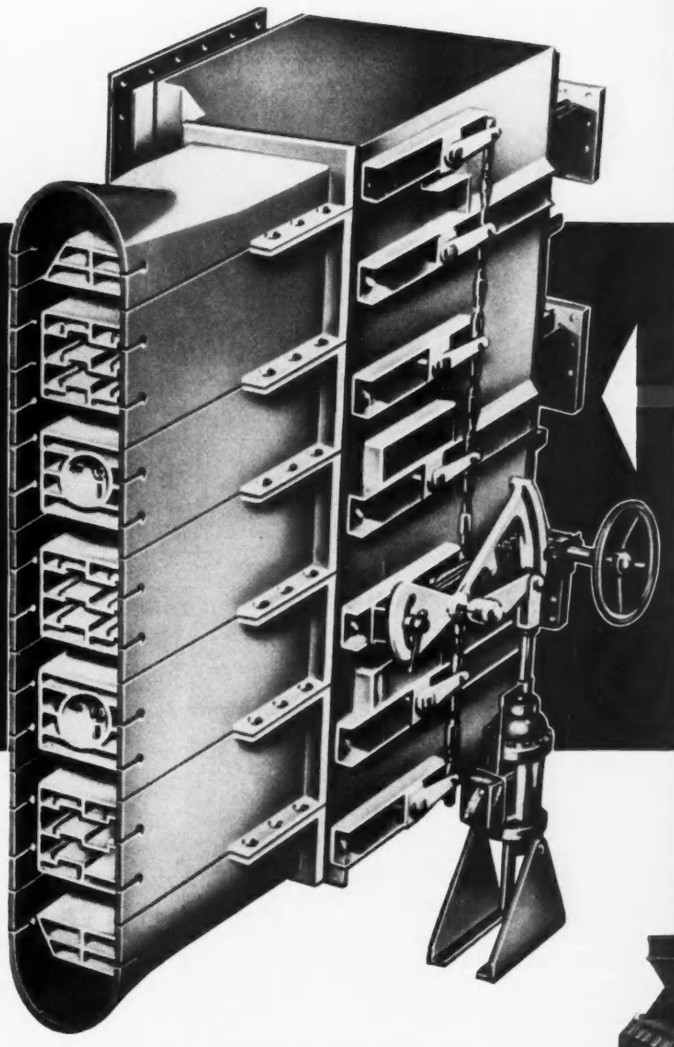

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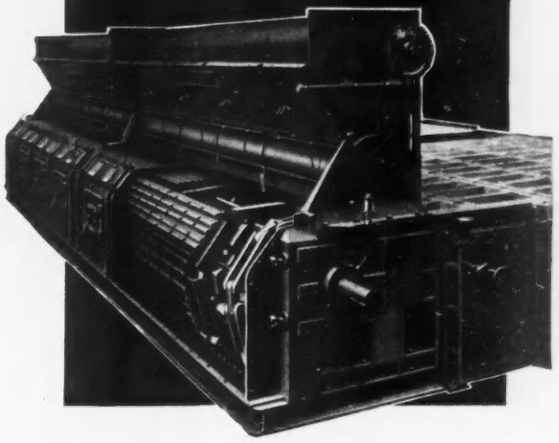

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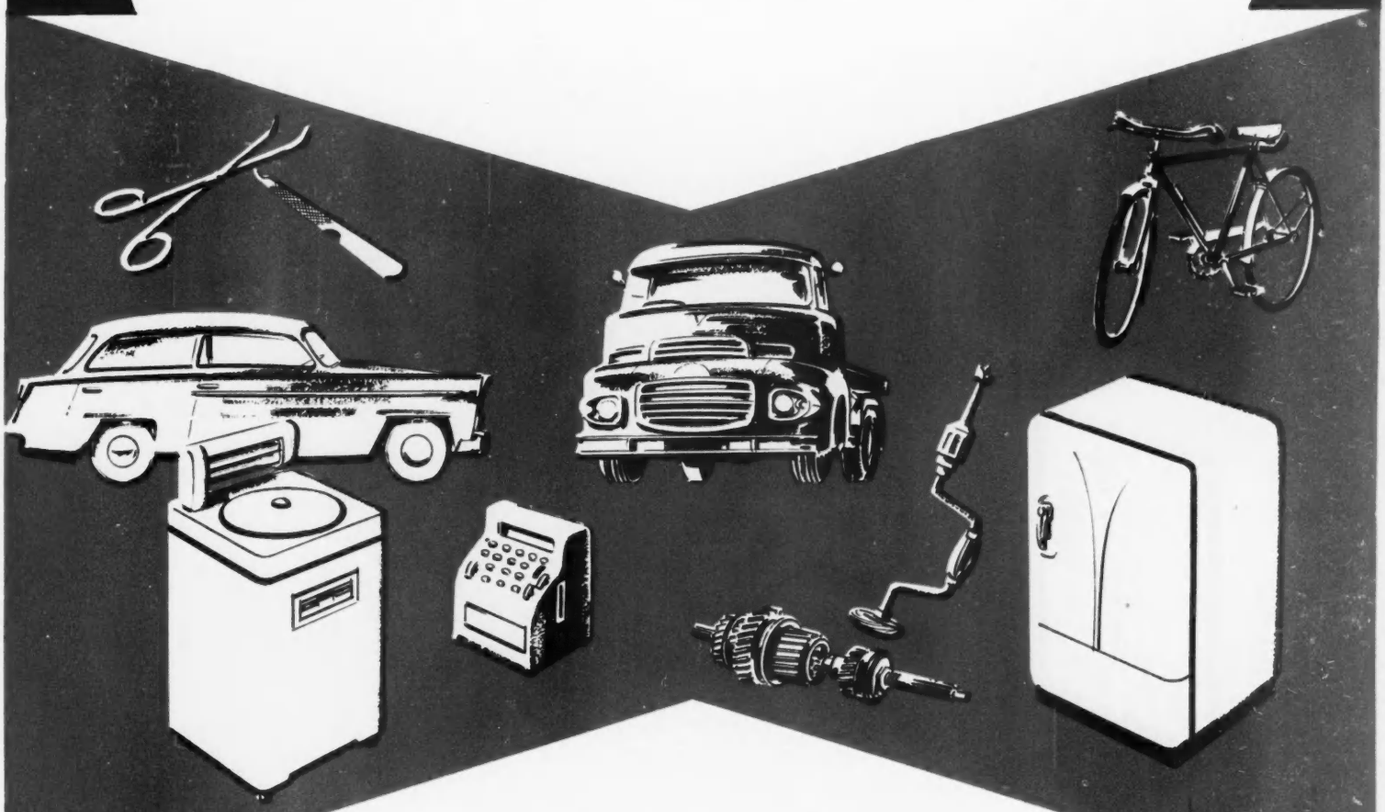

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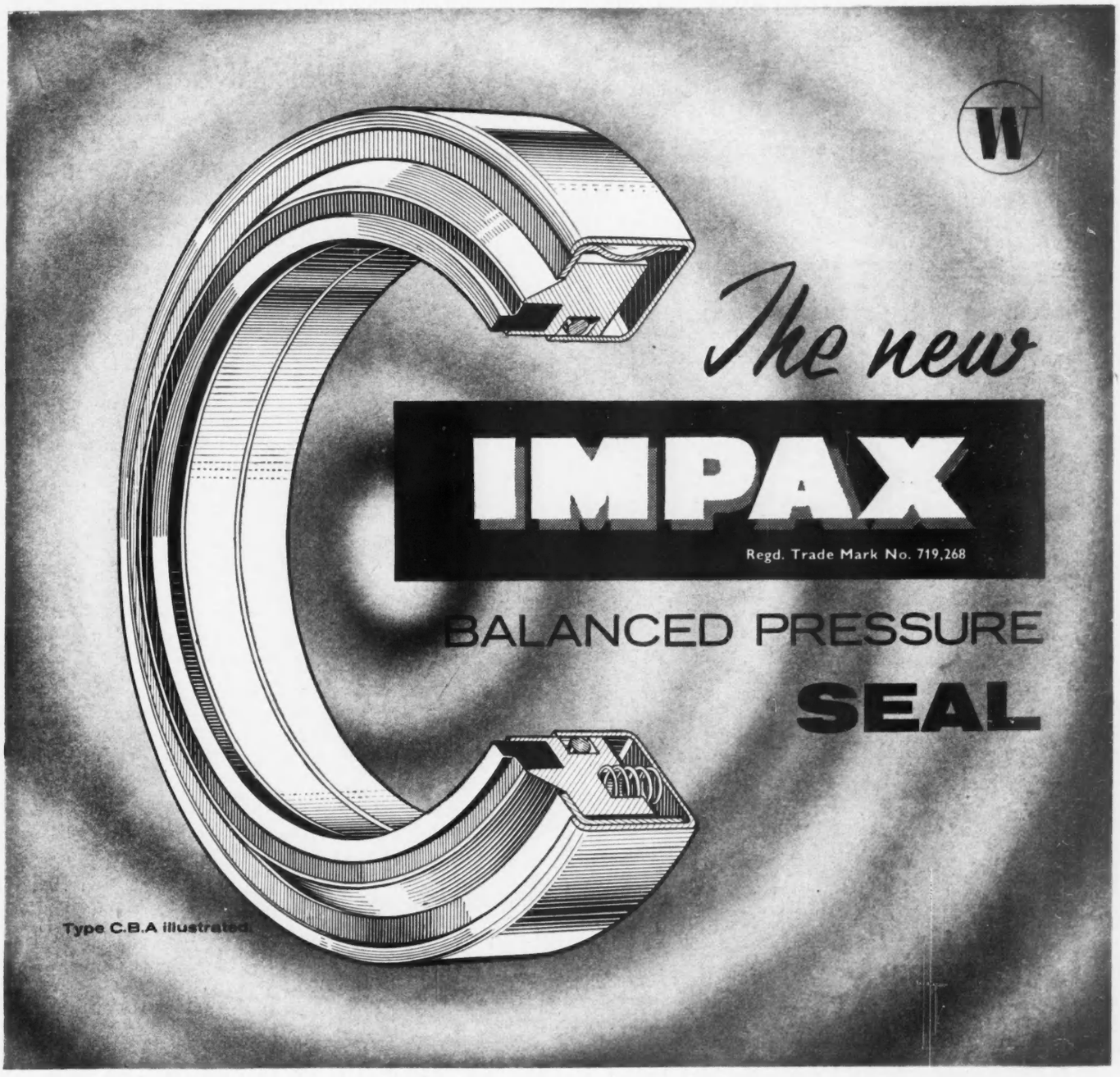

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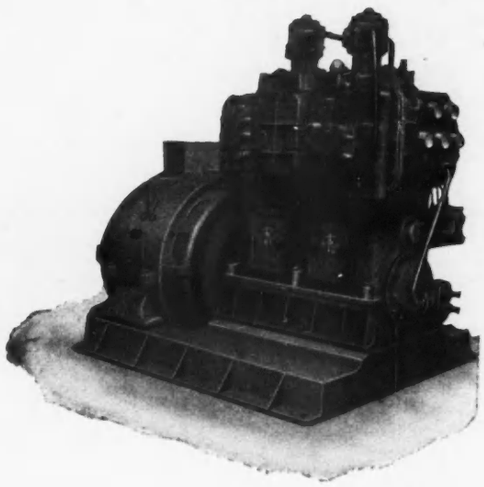

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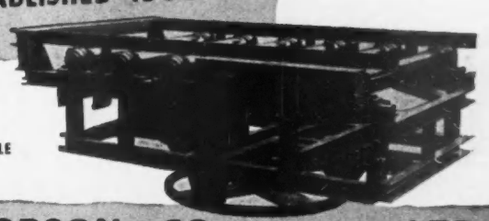

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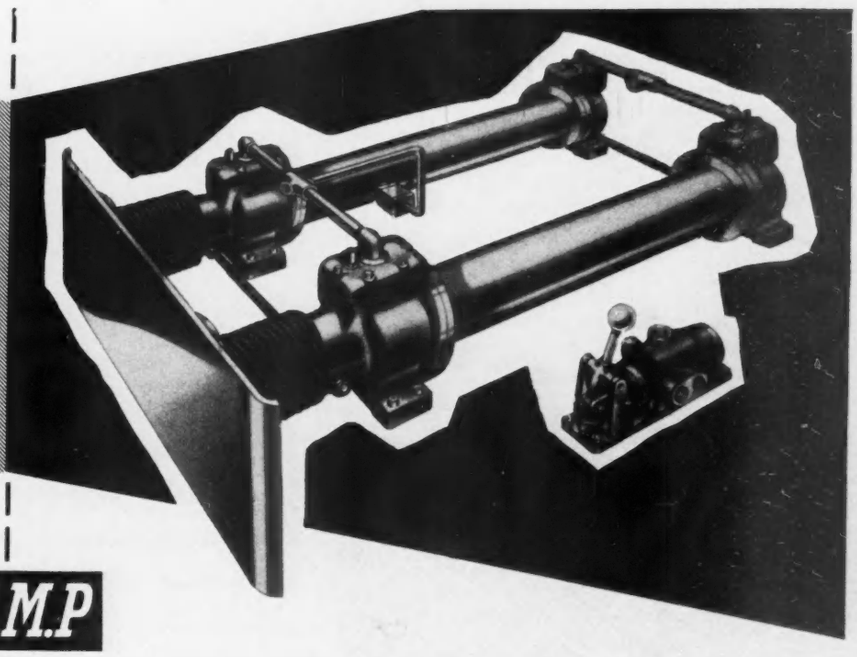

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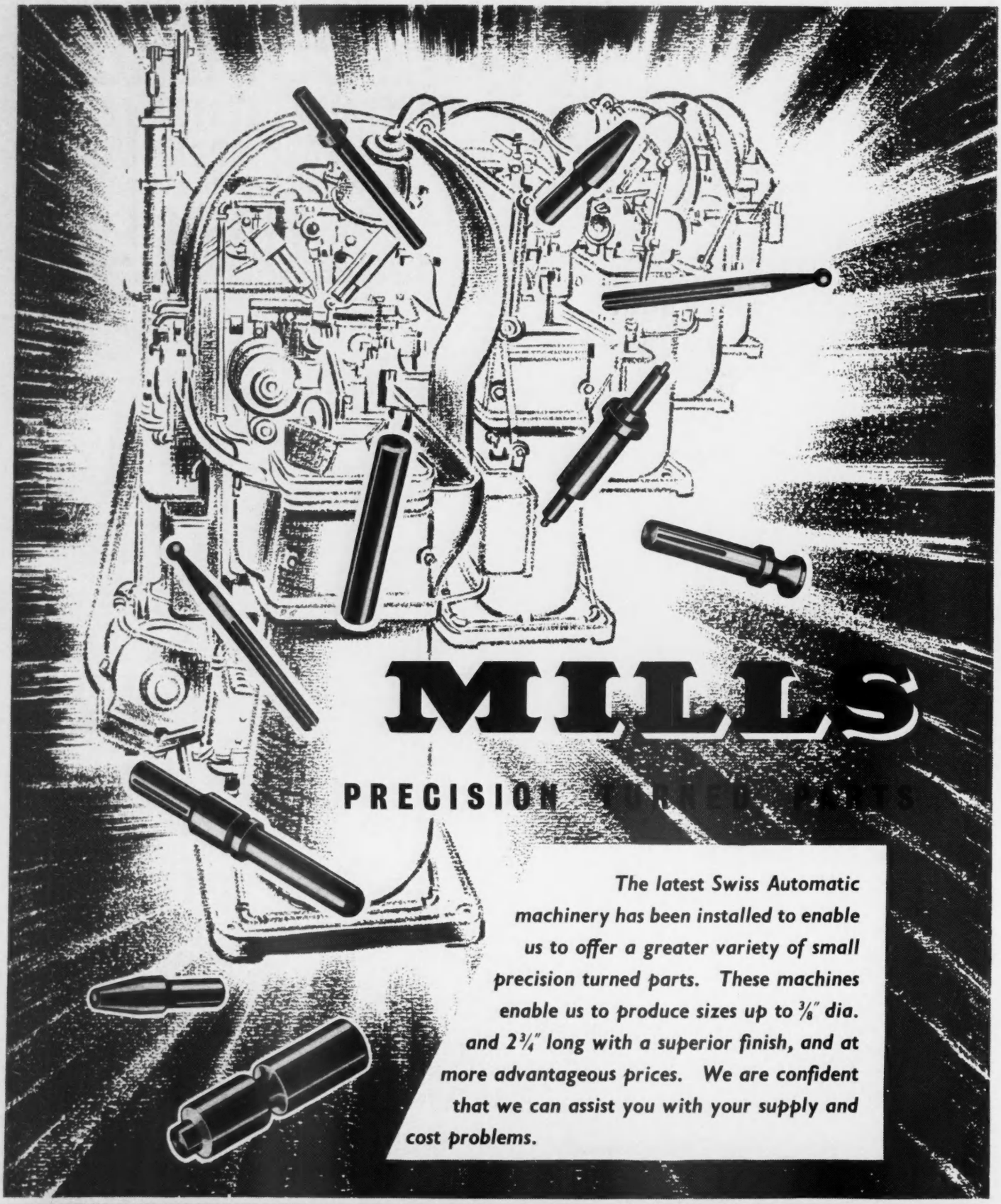

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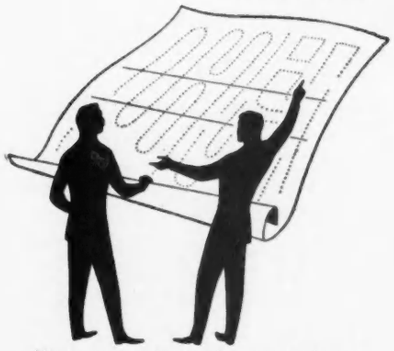

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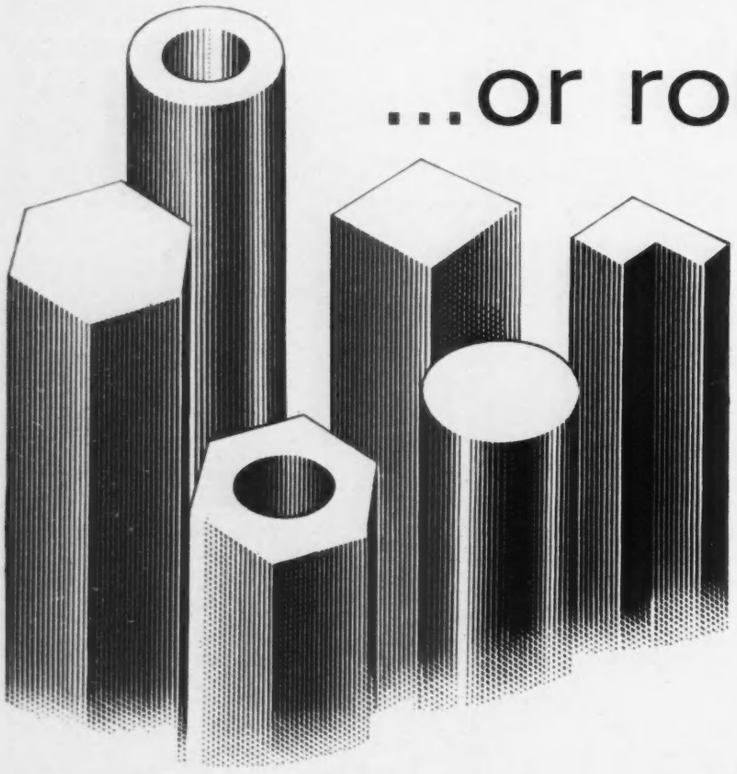

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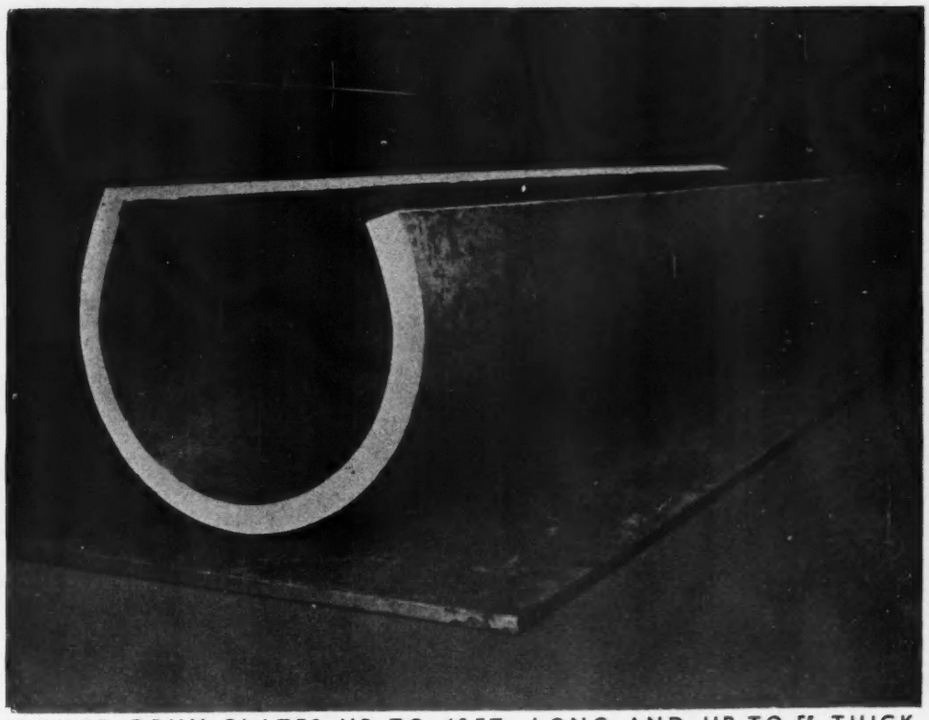

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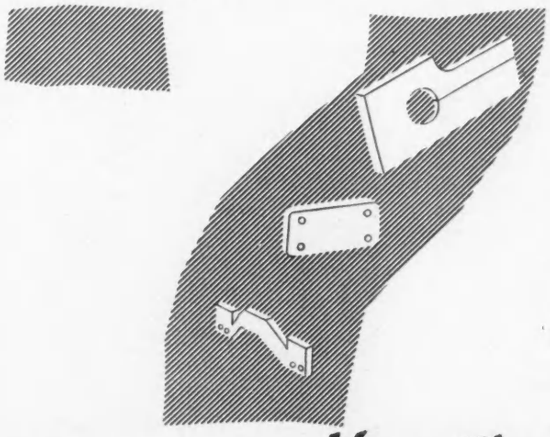

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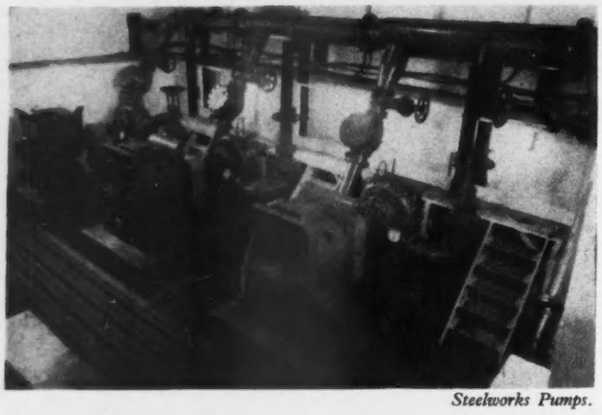
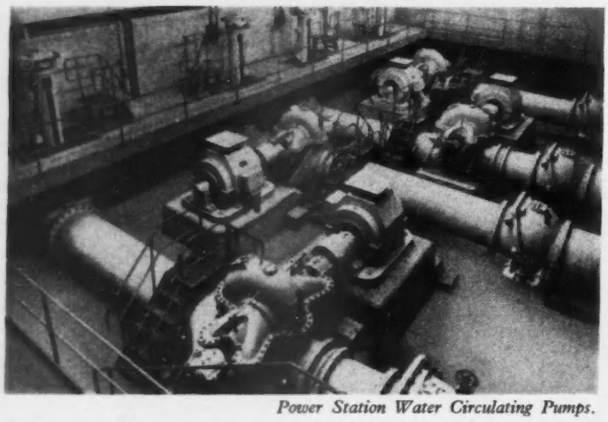
by Mather & Platt Ltd. have earned an unrivalled reputation for reliability and efficiency. The illustrations show just a few of their many applications.

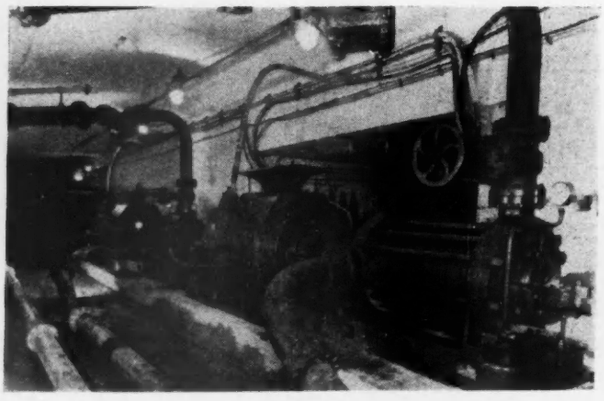


Steelworks Pumps.



Power Station Water Circulating Pumps.

Mine Drainage Pumps.



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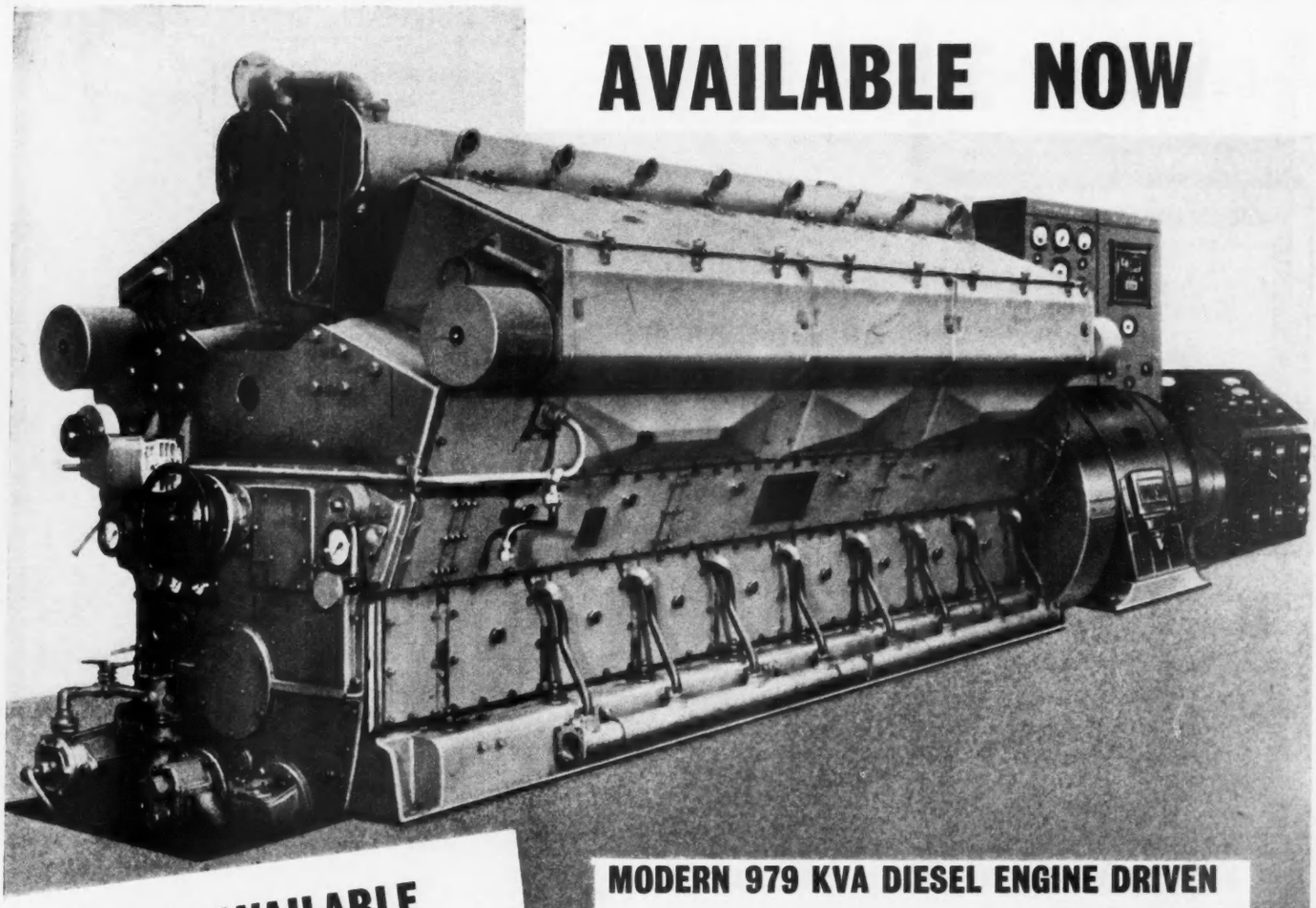

MODERN 979 KVA DIESEL ENGINE DRIVEN

ALTERNATOR SET

NEW/UNUSED 979 kVA 6,600 volts, 3-phase, 50 cycles 4-wire DIESEL ENGINE DRIVEN ALTERNATOR SET, direct coupled at 750 r.p.m. and incorporating 1,120 b.h.p., 12-hour rating normally aspirated 16-cylinder engine by **Mirrlees Bickerton & Day,** type JV16, arranged for air starting and complete with standard ancillaries and starting equipment. Direct coupled to alternator by **Brush Electrical,** revolving field, protected type, mounted on soleplates and complete with overhung exciter. Alternator complete with switchgear by **Reyrolle,** with automatic voltage regulator.

ALSO AVAILABLE

240 kVA 400/440 volts, 3-phase, 50 cycles, 4-wire DIESEL ENGINE DRIVEN ALTERNATOR SET, incorporating 300 h.p. vertical seven-cylinder engine by **Mirrlees Bickerton & Day,** type ULB.7. Direct coupled at 600 r.p.m. to alternator by **Metropolitan-Vickers,** with exciter. Set complete with standard ancillaries and switchgear.

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225 kVA 380/420 volts, 3-phase, 50 cycles, 4-wire DIESEL ENGINE DRIVEN ALTERNATOR SET, incorporating 262 h.p. vertical five-cylinder engine by **Mirrlees Bickerton & Day,** type TL.5. Direct coupled at 600 r.p.m. to alternator by **Brush Electrical,** with exciter. Set complete with standard ancillaries and switchgear.

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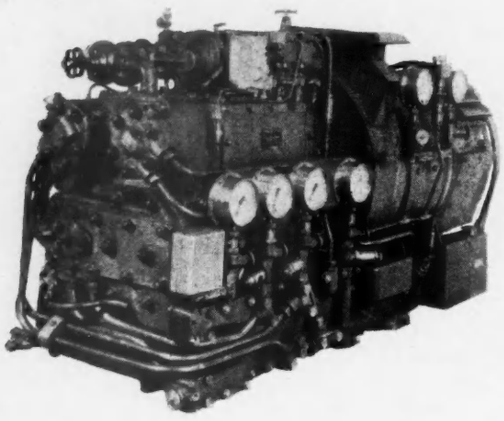
Waller crankless air compressor, capacity 50 cu. ft. per minute at all pressures up to 5,000 lb. p.s.i. A superb machine, remarkable for perfect balance and smoothness of running.



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OUR range of machines proves it.

Compressors	Single or multi stage reciprocating types: pressures up to 5,000 p.s.i.
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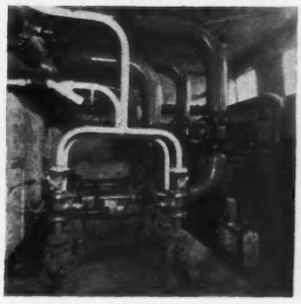
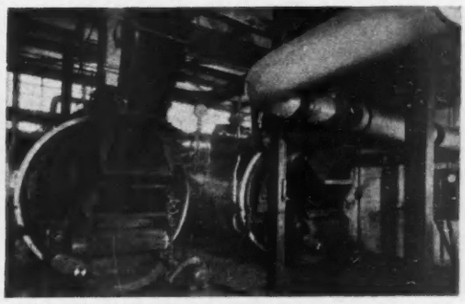
people of vision specify

High-pressure hot water pumping arrangement.



Two double pass economic boilers, each 6,000,000 B.t.u's per hr—chain grate stokers and coal and ash handling plant.



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Consulting Engineers: Cairns and Byles, Newcastle.

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heating & ventilating installations

This installation of high pressure hot water, general space heating and service pipe work for **Siemens Edison Swan Ltd.,** T.V. Tube Factory at Sunderland is representative of Steels' many and varied installations throughout the country.

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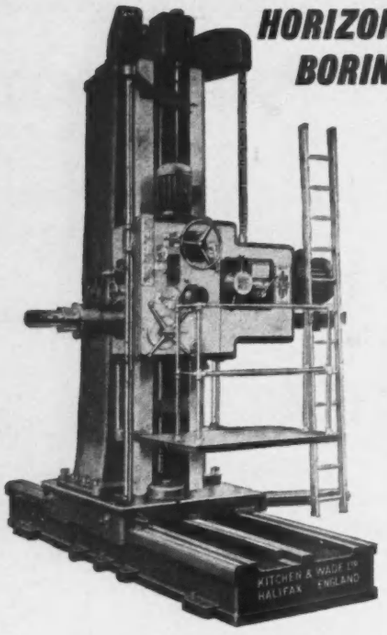

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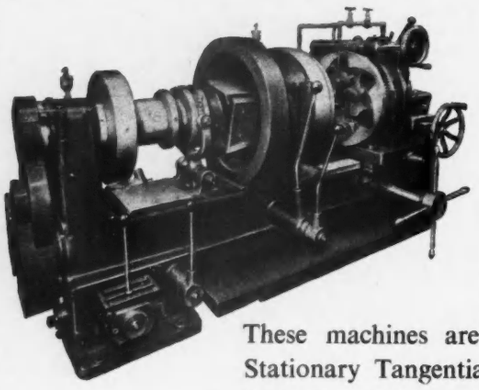

These machines are fitted with our Stationary Tangential Die heads and have been designed for production screwing of all sizes of pipes up to 12". They are in use wherever large quantities of piping have to be screwed, e.g. in Tube Works or in the Petroleum Industry. This type of machine can be supplied with 2-in., 4-in., 6-in., 8-in. and 12-in. capacity dieheads.

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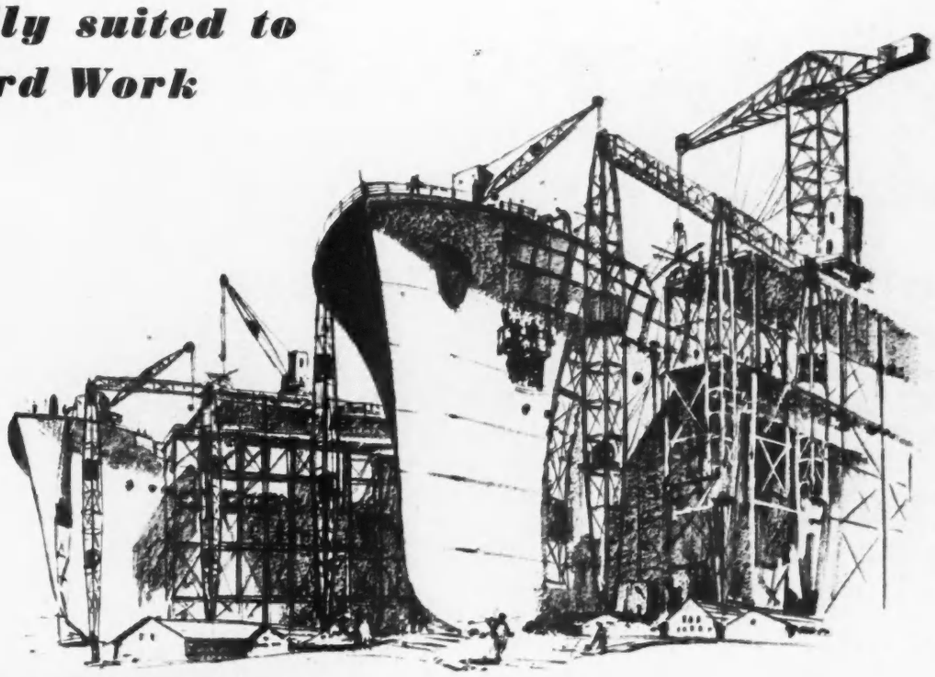

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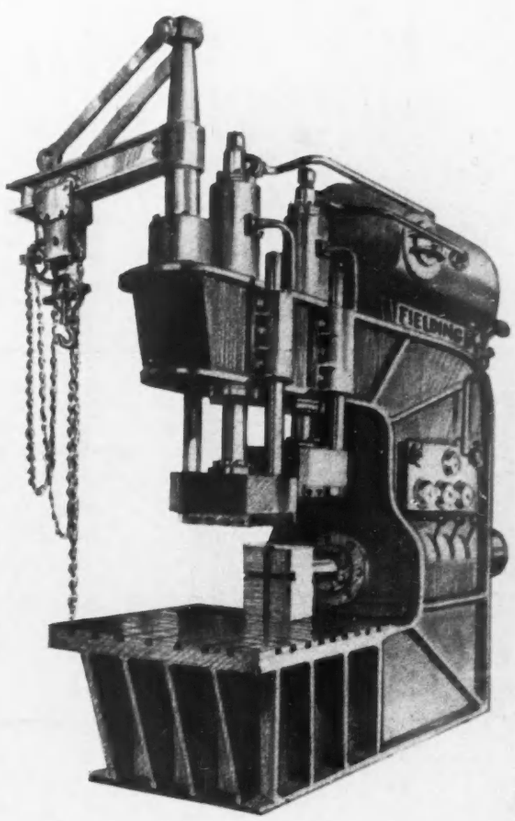
For full information on these and other FIELDING products, contact our Technical Sales Department.



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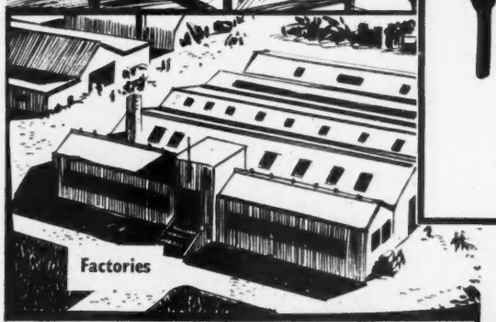
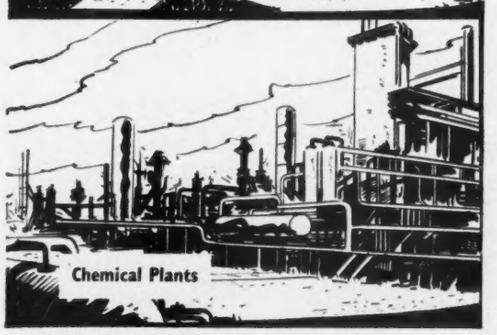
TRUST* K.600 KOMPAKS

to clear the air

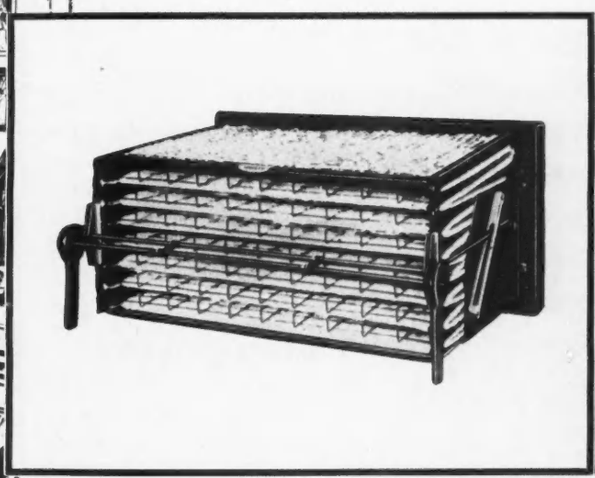


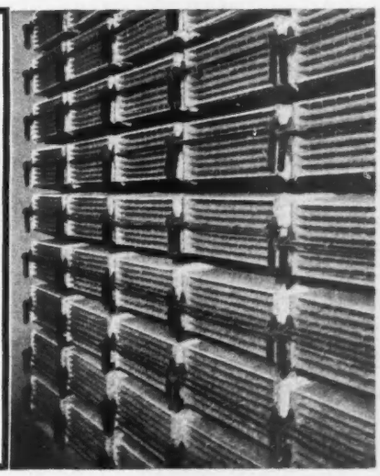


Perfected by years of research and development in the Vokes laboratories and in the field, the K.600 'Kompak' air conditioning filter is the most efficient as well as the most widely used of its type. Features which have led to its popularity include long life, reliability and extreme ease of maintenance.

Efficient air conditioning filters are essential in the provision of clean air inside buildings of all kinds. Impurities in the air supplied to factories can cause contamination of products or damage to valuable plant; in public buildings unfiltered air shortens the life of furnishings and decorations. Vokes K.600 'Kompaks' are installed in the air conditioning systems of large commercial and industrial office blocks, factories and engine test houses, public libraries and picture galleries, hotels and cinemas, concert halls, hospitals, multiple stores and establishments for scientific, pharmaceutical and photographic research and processing.

*** You can trust the K.600 'Kompak' because like all Vokes air filters it is fully tested in accordance with BSS.2831.**





Simply constructed and using an inexpensive, easily replaced filter medium, the K.600 'Kompak' has a normal rating of 600 cubic feet per minute with an initial resistance of 0.15 inches w.g. The actual velocity of the air passing through the developed area of the filter is only 22.5 feet per minute. Tested in accordance with BSS.2831, using highly penetrating test dusts, the 'Kompak' recorded an efficiency of 95% against Aloxite 50, and 93% against Aloxite 225.

The K.600 'Kompak' is ideal for general air conditioning, general ventilation and industrial air cleaning, particularly in areas where a sooty atmosphere prevails. It can also be supplied in flameproof and tropicalized versions, and a special super-efficiency type is available in which a layer of glass-wool backing the standard filter medium extends performance down to sub-micronic particles.

'KOMPAKS' FOR KELVINATOR

Kelvinator (Australia), who manufacture refrigerators for domestic and industrial purposes, use K.600 'Kompaks' as a second stage filter in their paint shop. The standard of paint finish acceptable is extremely high and efficient filtration of the dusty air is essential, particularly as the high gloss paint used accentuates any dirt defects. Since their installation the two banks of seventy filters each have given complete satisfaction, one bank having been in operation for two years without replacement of the filter medium. The intake (dirty) side of one bank is shown in the photograph above.

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A new range of totally-enclosed fan-cooled motors... Smaller, lighter than previous T.E.F.C. standards... Frame sizes identical with ventilated motors of the same rating... The T.E.F.C. range of Series 5 A.C. motors made by...

Electrically these motors conform to B.S. 2613:1957 Class E insulation. Dimensions conform to a new B.S. draft specification and are the same as those of Series 5 ventilated motors (B.S. 2960:1958). These T.E.F.C. motors can be supplied interchangeable with N.E.M.A. totally-enclosed, fan-cooled motors of the same rating.

The first batch—ratings from 1 to 7½ h.p. at 1400 r.p.m.—can be ordered now. The remainder of the range, 10 h.p. to 40 h.p. at 1400 r.p.m., will be available during the Spring.

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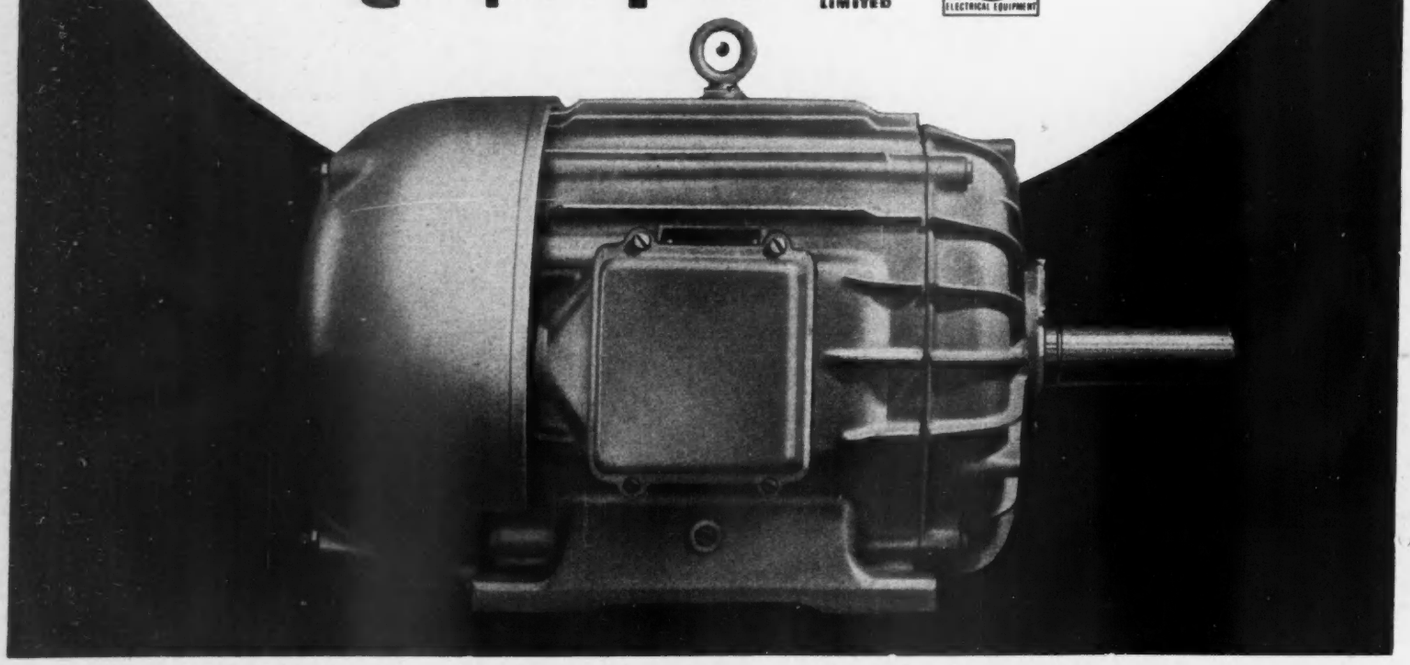

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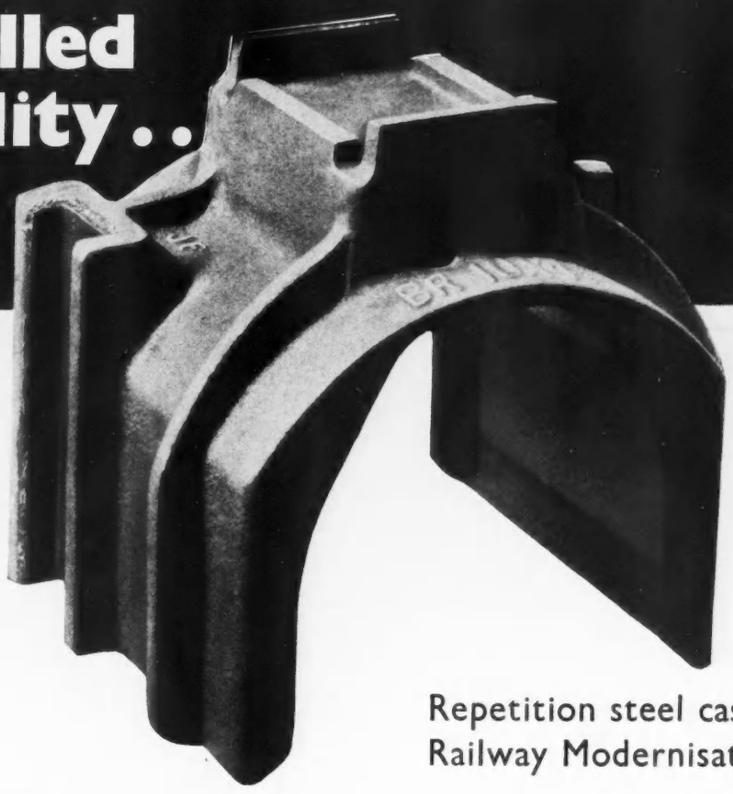
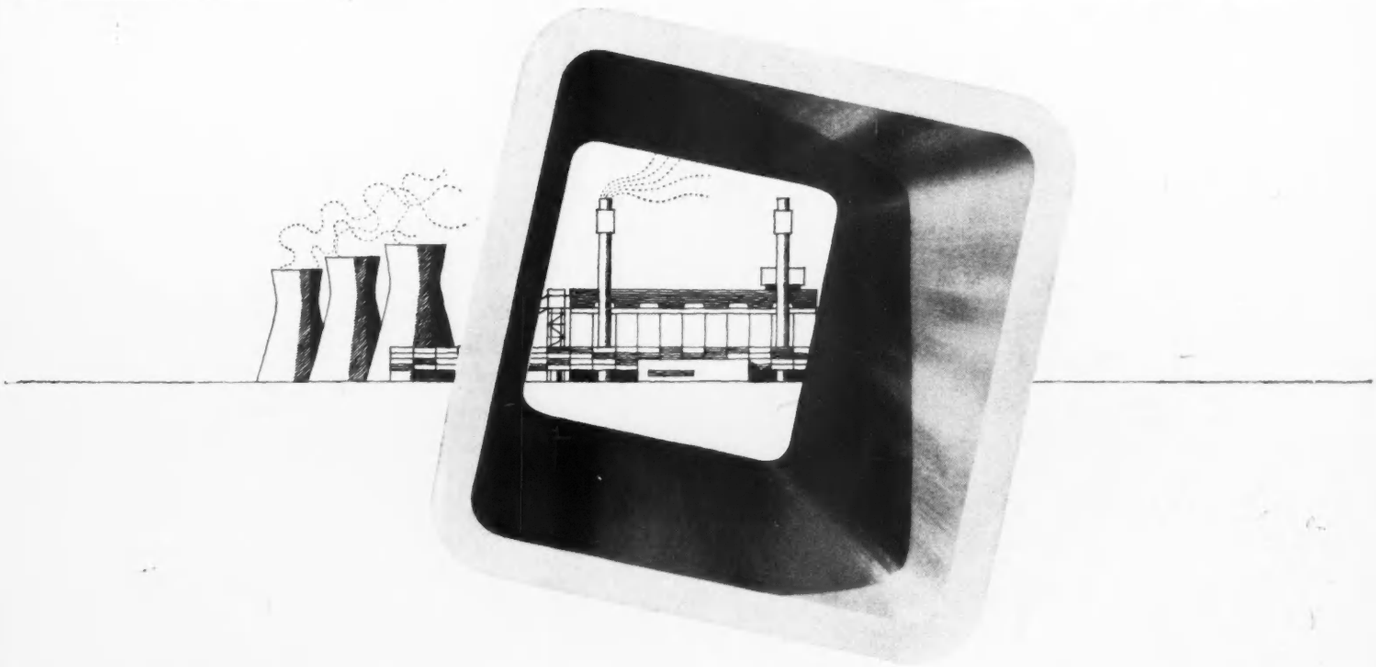


Repetition steel castings for the Railway Modernisation Programme

SPROTBOROUGH FOUNDRY

John Fowler & Co., (Leeds) Ltd., Sprotborough Foundry, Sprotborough, Doncaster



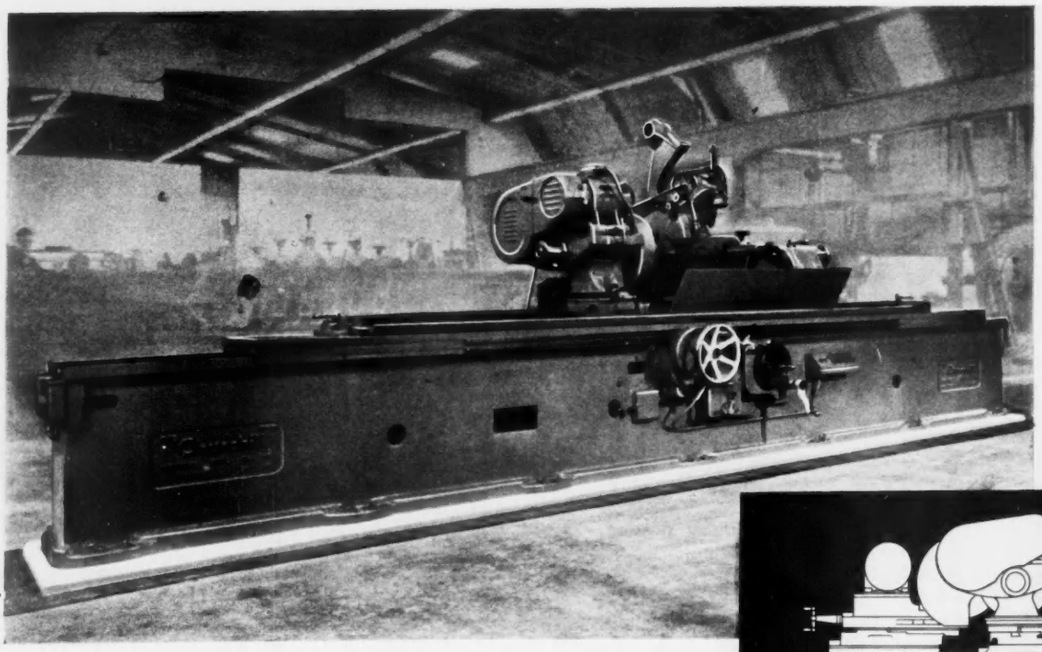
WHAT'S IN A TUBE?

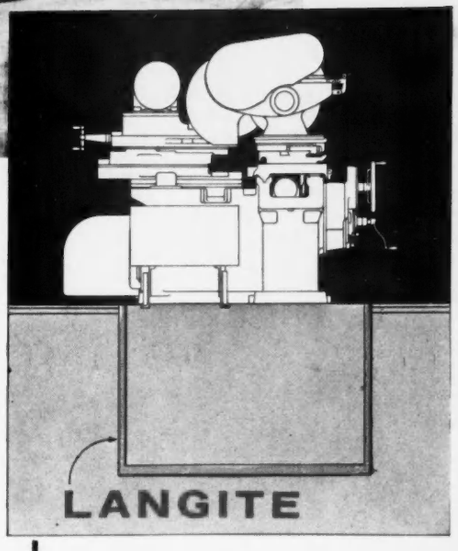
In every Chesterfield tube there is a lot of experience that doesn't show on the surface. Whether we are drawing a header for the boiler of a power station or turning out a miniature gas bottle to inflate a life-jacket, we make use of manufacturing techniques and individual skills that have taken anything up to 50 years to perfect. There is no substitute for the experience that goes into ***chesterfield tubes.***

THE CHESTERFIELD TUBE COMPANY LIMITED · CHESTERFIELD · ENGLAND · A COMPANY

CRC 60

Isolating vibration with LANGITE





The vibration problems brought to us vary a good deal: often it is necessary to provide a resilient mounting to a machine so that its shocks or vibrations are not dispersed to cause annoyance of personnel or interference with other machines.

This Churchill Universal Grinding machine is installed at Shell Refining Co. Ltd., Shell Haven, and comes in another category. The object here is to protect the grinder from vibrations arising from other machines in the plant, so that its accuracy may be unimpaired.

The grinder is carefully levelled and set upon a massive reinforced concrete block, which in turn is cushioned underneath and at the sides on pads of resilient Langite 4V.

The result obtained by these simple means is wholly satisfactory.

IMPORTANT USERS

Langite anti-vibration pads are also supplied to:
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National Coal Board,
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ANTI-VIBRATION PADS OF

LANGITE

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